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THE

Mucous Membrane of the Uterus

WITH SPECIAL REFERENCE TO

THE DEVELOPMENT AND STRUCTURE OF THE DECIDUÆ.

BY

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WITH FOURTEEN ILLUSTRATIONS.

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CONTENTS.

PAGE

INTRODUCTION..... 5

PART I.

THE MUCOUS MEMBRANE OF THE WOMB IN ITS DEVELOPMENT UP TO THE TIME OF PUBERTY..... 8

PART II.

THE MUCOUS MEMBRANE OF THE WOMB DURING ITS PERIOD OF MATURITY AND FUNCTIONAL ACTIVITY, FROM THE TIME OF PUBERTY TO THE CHANGE OF LIFE..... 11

A. The Fully Developed Membrane during its Period of Rest..... 11

B. The Uterine Mucosa during the Menstrual Period..... 13

Naked Eye Appearance.
Microscopic Appearance.
Cause of the Menstrual Hemorrhage.
Temporal Relation of Menstruation to Ovulation.

C. The Mucous Membrane of the Uterus during Pregnancy—the Deciduæ..... 21

1. Normal Development of the Deciduæ.

Definition of Terms Used

The Deciduæ in the First Month..... 23

The General Appearance of the Uterine Cavity.
Decidua Vera.
Decidua Serotina.
Fixation of the Ovum.
Decidua Reflexa.
Relation of the Chorion to the Serotina.

The Deciduæ in the Second and Third Month..... 32

Decidua Vera.
Decidua Serotina.
Decidua Reflexa.

53955

PAGE

From the Fourth Month to the Termination of Pregnancy..... 35
General Appearance of the Membrane.
Structure and Development of the Placenta..... 38
Retrograde Metamorphosis of the Membranes..... 42
Macroscopic Appearance.
Decidua Vera..... 43
Decidua Reflexa..... 47
Decidua Serotina..... 49
Retrograde Metamorphosis, Microscopic..... 51
Concerning the Expulsion of the Deciduæ at Term..... 51
In Abortion.
2. Appearance of the Decidua enveloping the Aborted Ovum..... 56
3. The Decidua in the Uterus Bicornus, and in Extrauterine Pregnancy..... 58
D. The Regeneration of the Mucous Membrane after Parturition..... 59

PART III.

THE MUCOUS MEMBRANE AFTER THE CHANGE OF LIFE..... 64

THE

MUCOUS MEMBRANE OF THE UTERUS.

INTRODUCTION.

In the fall of 1871, while pursuing my microscopic studies in the pathological laboratory of the General Hospital of Vienna, I was requested by my honored friend, Prof. Späth, Director of the Second Obstetrical Clinic, to examine an aborted mass, probably an ovum of the sixth week, in order to determine the structure and condition of the various tissues.

The outer wall of this ovum was formed by a thick, resistant membrane, which presented a most striking and interesting microscopic appearance; the tissue consisting in some places of large, well-marked epithelial cells, whereas in others it presented rather the appearance of young connective tissue; throughout its entire extent it was traversed by large, irregular sinuses, between which and the openings of apparently well-defined ducts, which appeared upon the smooth inner surface of the membrane, no direct connection could be traced; the capillaries were large, and distended with blood.

The specimens were examined by many, even by the veteran Rokitansky himself, who turned away with a word of thanks, but vouchsafed no explanation. The structure, it was evident, did not appertain to the ovum, but to the womb, it could be nothing else but the decidua; was it normal? was it pathological?—these questions no authority could answer, and Dr. Kundrat, first assistant to Prof. Rokitansky, appreciating equally with myself their high scientific and practical interest, we determined to seek for the answer, to study this still little-known structure, and give to the profession the microscopic anatomy

of the decidua, of the mucous membrane of the womb during all its phases and physiological changes.

The pathological laboratory of the Vienna Hospital, within whose walls the post-mortem examinations of the immense hospital, as well as the legal inquests of the gay capital, are held, was perhaps the only place where these researches could be undertaken, as none other could have yielded us the extent and variety of the rare material necessary.

In the course of the winter we were enabled to examine a large number of uteri in all possible conditions; more material was afforded by the post-mortems of the Charité and the obstetric clinic of Berlin during the summer of 1872, but above all by the extensive collection of ova in the anatomical museum of Berlin. These latter specimens I was enabled to study most thoroughly, as the unequalled liberality of my honored teacher, Prof. Reichert, had placed them entirely at my disposal.

The result of these researches was announced in a paper which was read by Dr. Kundrat before the "Gesellschaft der Aerzte" of Vienna on the 25th of October, 1872, and appeared in Stricker's "Medizinische Jahrbücher" for 1873.

The simultaneous publication in this country, which had been decided upon, was delayed, and other questions engrossing my attention, I intended to lay this matter aside for the present, knowing that such of the profession as were more especially interested in the results obtained, would refer to the German publication, and hoping at some future time to present a paper which would more thoroughly exhaust the subject, as the wealth of material accumulated would enable me to do.

To this resolution I have not been able to adhere; I deem it important that certain of the views expressed in our previous publication, which I cannot endorse, and which were developed after my departure from Vienna, should be corrected; other circumstances also, together with the request of friends, force me to what I might almost call a republication of our paper of 1873; the illustrations are all copied from this. I will not confine my remarks to the decidua, the mucous membrane of the womb during pregnancy, its period of highest vitality and greatest physiological importance, but will briefly discuss the structure of the uterine mucosa in its various changes, from its

first appearance in the fœtus, throughout its period of development in the child and its long season of maturity and functional activity, to the time of involution and inactivity. This I deem necessary in order that the picture presented may be a more perfect one, and that the result of our investigation may be more fully understood, as the macroscopic, and more especially the microscopic changes, which the mucous membrane of the womb undergoes during the various phases of female life, have never been thoroughly studied and defined.

I shall endeavor to present an accurate delineation of the membrane in all its various conditions *as characterized by the specimens examined;* confining myself strictly to these, I shall avoid a discussion of the numerous conflicting theories, calling attention merely to the more important particulars in which I deviate from current and accepted doctrines.

My conclusions are based upon the examination of a large number of uteri in various conditions, and of ova as well as uteri during all the periods of gestation. Seventeen uteri were examined containing normal, healthy ova in all stages of pregnancy, from the second week after conception to full term; of two hundred others, some were virgin wombs, some exhibited the menstrual condition, some that after abortion, and others that from the first day to the sixth week after delivery; in addition to these a large number were examined before the establishment of functional activity.

Twenty-nine of the ova were products of less than a month's gestation, as till larger number examined belong to later periods.

3003 Locust St., St. Louis, *April*, 1875.

PART I.

THE MUCOUS MEMBRANE OF THE WOMB IN ITS DEVELOPMENT UP TO THE TIME OF PUBERTY.

THE mucous membrane of the womb before it has attained functional maturity, as in the child, consists simply of round or polygonal cells with round nuclei imbedded in a very fine network of connective tissue. It possesses this same formation in uteri of incomplete or retarded development, which macroscopically also resemble that of the child in the flat hour-glass shape and in the prominence of the cervix. Spindle-shaped cells are found only around the vessels and near the surface.

All these elements, as well as the ciliated epithelium which lines the surface, are more delicate than in the fully developed uterus; the essential difference between this and the infantile womb, however, consists in the absence of all glandular structure in the latter.

No glands are to be found in the even, hard, uterine mucous membrane of the fœtus; nor do we meet with any trace of them during the first years of life, during which the membrane increases but little in thickness, averaging about 0.0078 inch (0.2 mm.), whereas in the seven months fœtus it measures between 0.0035 and 0.006 inch (0.09–0.15 mm.).

The small depressions existing in the mucosa near the lateral angles of the uterine cavity are not indicative of beginning glandular development, being nothing more than radiations of the palmæ plicatæ, which, in children, are continued beyond the cervix.

A change takes place in the third or fourth year, at which time the membrane has increased in thickness to 0.0118–0.0196 inch (0.3–0.5 mm.), and the first traces of the develop-

ing glands appear in the shape of small crypt-like depressions, either simple, or in clusters of two or three, with a common opening; a delicate epithelium lines these sinuses, for glands we cannot yet call them.

From this time onward very few changes take place until after the tenth year, when the womb develops more rapidly and approximates in shape to that of the mature organ at puberty. The mucous membrane has now attained a thickness of 0.0275–0.0315 inch (0.7–0.8 mm.), and the glands are more numerous and more completely developed, forming no longer shallow crypts, but straight ducts 0.00098 inch (0.025 mm.) in diameter, extending to a greater depth than before, sometimes throughout the entire thickness of the mucosa and even into the muscular stratum.

This process of development once inaugurated now steadily progresses, and in girls of twelve or thirteen (in the climate of central Austria, lat. 48° N.) we find the changes still more marked.

Though the mucous membrane is not yet more than 0.0275 –0.0315 inch (0.7–0.8 mm.) in thickness, it already contains well-defined glands, still rectilinear in their upper third toward the free surface of the membrane, but slightly curved or serpentine at their fundus.

The great difference of race among the inhabitants of Vienna, and the fact that many of the uteri examined were those of girls who had long suffered with tuberculosis, caries, coxitis, and other chronic and wasting diseases which may have retarded development, preclude any generally applicable statement as to the precise time of life at which the full development of the membrane takes place. This same intermingling of races and nationalities takes place in a much greater degree in our own country, which, even in itself, presents all varieties of climate.

Notwithstanding continuous attention to the subject, I have been unable, in our own city, to make any investigations bearing upon the development of the membrane, interesting as it would be to ascertain to what degree a change of latitude, climate, and habits would influence this process; the example of the Jews, whose Oriental characteristic of early puberty has adhered to them for ages throughout all climates, leads me to

believe that the effect of such a change would not be a very marked one. I must content myself with stating that the development of the uterine glands begins, in the first years of life, by the growth of the surface epithelium from without inward, in the form of small crypts, few at first; these increase, especially in the seventh and eighth year, in number and depth, forming narrow ducts; from this time onward their development progresses slowly, but steadily, and is completed by more rapid strides immediately before puberty.

PART II.

THE MUCOUS MEMBRANE OF THE WOMB DURING ITS PERIOD OF MATURITY AND FUNCTIONAL ACTIVITY, FROM THE TIME OF PUBERTY TO THE CHANGE OF LIFE.

A. THE FULLY DEVELOPED MEMBRANE DURING ITS PERIOD OF REST.

The mucous membrane of the womb is characterized by the absence of even the slightest trace of submucous areolar tissue, and by its peculiar substratum of connective tissue abounding in cells. It appears in the virgin, non-menstruating womb, after removal of the superjacent transparent mucus, as a delicate, soft, pale-gray or grayish-red layer, which, owing to the absence of the submucosa, is closely and inseparably attached to the muscularis.

The thickness of the membrane is a little over 0.04 inch (1.0 mm.) at the fundus and the anterior and posterior walls, diminishing toward the sides, the cervix, and the tubar ostia.

Vertical sections exhibit a system of delicate white striæ, indicative of the glands which traverse the membrane and open at the surface.

These glands are tubular, often bifurcated in their lower third, and round or oval on transverse section; they may be said to run parallel to each other, perpendicular to the surface of the membrane upon which they open; yet, strictly speaking, this is only true of the course of the glands in their upper half, and even here this course is not straight, but wavy, like the duct of a sweat gland. In their lower half they deviate much more, being more irregular and tortuous, the fundus curved, sometimes even so much as to run parallel to the muscular layer.

The fundus of a gland is very rarely found extending beyond the mucosa into the septa of connective tissue between the muscular fasciculi.

The glands are not equidistant throughout the entire depth of the mucous membrane; they are less wavy near the surface, and, moreover, narrow somewhat toward the mouth, so that they do not approximate as closely as in the deeper strata, where they bifurcate and become more sinuous.

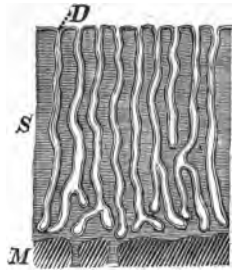

FIG. 1.—Vertical section of the mucous membrane of the normal virgin womb.
Magnif. 40 diam.
S. Mucous membrane.
D. Uterine glands.
M. Muscular stratum.

The uterine glands, unlike most others, possess no basement membrane, but appear simply as epithelial tubes, composed of cylindrical ciliated cells, and are directly imbedded in the substratum of connective tissue; neither the most careful preparation, nor the best of lenses, have enabled me to detect a membrana propria.

The shape of the cells is polyhedral when seen in perspective, but in horizontal preparation (in profile) it appears somewhat conical, tapering from the base toward the free end. In fresh sections and in specimens prepared by teasing, the body of the cell and the nucleus are seen to be granulated.

The ciliæ can only be seen in very fresh specimens, and at favorable periods, though the remnants of the ciliary lining are recognizable in less recent and even in hardened specimens.

The substratum in which the glands are imbedded has been compared by Henle to the interglobular tissue; in the virgin womb it consists almost exclusively of round and spindle-shaped cells, of so delicate a character that in hardened specimens the faint outlines of the cell-body are mostly invisible, and the whole tissue presents the appearance of a structureless homogeneous mass with imbedded nuclei.

Near the surface of the membrane the round cells are most abundant, while the spindle-shaped cells predominate in the deeper layers, especially in proximity to glands and blood-vessels, where they assume a more fibrillar appearance, and accompany the course of those structures in parallel bundles.

A reticulum of delicate fibres can be traced between the cells—best visible in fresh, teased specimens; those fibres, like the spindle-shaped cells, are also collected in more compact longitudinal bundles in the deeper layers around glands and blood-vessels, while in the upper (inner) layers they divide irregularly, forming a loose mesh-work.

These fibrillar bundles of connective tissue, in the deeper layers of the membrane, radiate outward, and are lost in the interfibrillar septa of the muscularis, thus forming a firm connecting link between the two structures. Muscular fibres I have never been able to demonstrate, even in the deepest strata of the mucosa.

As the connective tissue of the mucosa is continuous with that of the muscularis, so the glandular cells are directly continuous with the ciliated epithelium lining the inner surface of the mucous membrane.

This is the normal appearance of the inactive uterine mucosa from the time of its complete development to its involution, and we will now study it in the state of functional physiological activity.

B. THE UTERINE MUCOSA DURING THE MENSTRUAL PERIOD.

In any case in which the ovary reveals a recently ruptured Graafian vesicle, or even a fully developed corpus luteum, while the uterus and its appendages are tumefied and congested, the mucous membrane will be found in an essentially different condition from that just described, even when the hymen is intact, *i.e.*, when the state is unquestionably that of menstruation, and not of conception.

The membrane is swollen 0.118–0.236 inch (3.–6. mm.) in thickness, of an almost pulpy consistency. Its surface is puffy, wavy, and in places reveals the delicately injected capillaries, after removal of its coating of whitish, opaque mucus, occa-

sionally tinged with blood. In some cases the injection is more marked in certain parts of the membrane, while in others, especially in those of sudden death, not due to hemorrhage, it is intense throughout, giving it a uniformly red appearance.

The greater thickness of the mucosa in the fundus and the central portion of the anterior and posterior walls of the uterus, and its decrease toward the tubes, the lateral angles, and the cervix, is much more marked in this tumefied menstrual uterus than when that organ is at rest.

After removing the mucus, the openings of the glands, apparently enlarged, become much more distinctly visible, especially after the specimen has been hardened in bichromate of potassa, and in vertical sections, even of very recent specimens, the glands themselves are distinctly seen by the naked eye in their entire length as white striæ.

The microscopic changes which take place are equally marked, and prove the increased thickness of the mucosa to be due to a tumefaction, I should perhaps more properly say hypertrophy of its superficial layers; its upper half, in which the stroma appears less compact, is rich in embryonic cells, and has grown far above the original gland openings, circumvallating them, and thus causing the funnel-shaped depressions, those small pits, which make the ostia seem enlarged.

The tumefaction is owing to a proliferation of the round cells of the stroma and an enlargement of the individual cells of all kinds, including those of the glands themselves, as well as an increase of the succulent, homogeneous, intercellular substance.

The enlargement and the increase of round cells is marked only in the upper layers, becoming less prominent in the deeper strata; it is not found at all in the tissue surrounding the fundi of the glands, which remains unchanged.

The glands themselves, throughout their greatest extent, are very much enlarged, often two and four fold; the fundi, however, like the stroma surrounding them, remain unaltered, the ostia, with the upper portion of the ducts, are also of normal width, sometimes even narrowed by the pressure of the more forcibly expanding stroma.

Vertical sections show that the increase in the length of the glands, if we measure their length throughout their tortuous course, is even greater than the increase in the thickness of the

mucous membrane, which is accounted for by their numerous shallow sinuosities in the upper layers and the more marked undulations in the deeper strata.

The glands are hence seen in such sections, especially in their central layers, as round, irregular spaces, partially lined with cylindrical epithelium, superimposed upon each other, and separated by very narrow portions of the substratum (Fig. 2, D D); nearer the surface we can trace them in their continuity. The vessels are enlarged and gorged with blood, especially in such places as show an injection or a reddish tinge to the naked eye.

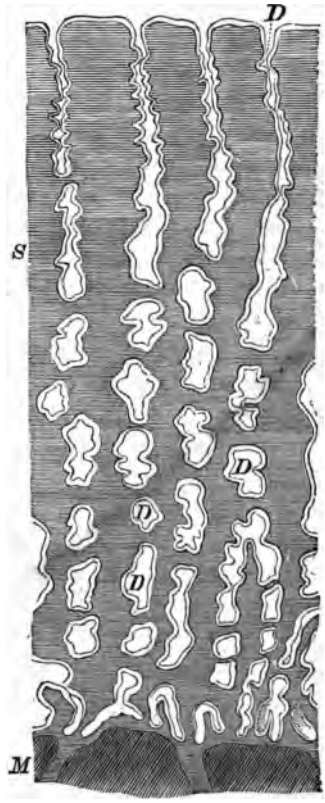

FIG. 2.—Section through the mucous membrane of the menstrual virgin womb. 40 ×.
S. Mucous membrane.
D. Uterine glands, with funnel-shaped ostia.
M. Muscular stratum.

The process of segmentation, which I have observed in the cells of the stroma and of the glands, differs in no respect from the well-known features of cell proliferation as observed in other tissues and under other circumstances.

A new formation of blood-vessels I have not been able to discover.

The changes just described are unquestionably due to menstruation, as I have observed them in virgin wombs concomitant with very recent corpora lutea, which we know to be indicative of the escape of ova.

Anatomical experience, as I will show, does not bear out the current theory that the menstrual changes of the mucous membrane just described come and go as rapidly as the menstrual period itself.

In two of our cases, girls who died suddenly a few days be-

fore the catamenial period, the precise time of which could unfortunately not be ascertained, and in a number of others in which we had no record of the time of menstruation, the mucous membrane already presented the less compact, tumefied appearance characteristic of the menstrual condition, while no signs of ovulation, no recently ruptured follicles, could be found in the ovaries.

In other cases in which the catamenial discharge was said to have ceased several days before death, and in which well-developed corpora lutea were found, the mucous membrane was still more or less tumefied, though not to the same degree as during the continuance of the hemorrhage.

This is the condition I have always found existing soon after cessation of the catamenia; in not one of the many uteri examined at such periods was the mucous membrane, or even its superficial layer, found wanting, a fact which I should have deemed wholly unnecessary to mention, were it not that theories, such as Pouchet's, that the mucous membrane is shed at each catamenial period, seem still to be accepted by some; quite lately it has again been revived by Williams (On the Structure of the Mucous Membrane of the Uterus and its Periodical Changes, *Obstetrical Journal of Great Britain and Ireland*, February and March, 1875), who would have a new mucous membrane formed in each intermenstrual period, only to pass away as "sanguineous debris" with the next catamenial flow. He tells us that "when hemorrhage has taken place into the membrane, it undergoes rapid disintegration and becomes entirely removed." After having established this physiological improbability, to which we can find nothing analogous in the human system, he endeavors to explain the extremely rapid restoration of the membrane by a histological incongruity. As he has left nothing of the mucous membrane from which its regeneration may take place, he allows it to spring from the muscular tissue. To use his own words: "This membrane is produced by proliferation of the elements of the muscular wall of the organ, the muscular fibres producing the fusiform cells, the connective tissue the round cells, and the groups of round cells in the meshes formed by the muscular bundles the glandular epithelium." By such fallacies alone can theories like the above be explained.

The facts gathered warrant the conclusion that the mucous membrane of the womb begins to increase in thickness and succulence as the time of menstruation approaches, that this tumefaction is most marked during the period itself, and gradually decreases after the cessation of the catamenial discharge.

We rarely find a completely normal, inactive, uterine mucosa which seems to indicate that the actual period of rest for that membrane is much shorter than is generally assumed.

During the period of menstrual hemorrhage, and shortly after, until the restoration of the membrane to its normal condition, the cells of its tissue are more opaque and granular.

Although there is a more or less marked accumulation of fat granules within the cells of the upper layers of the membrane, during and immediately after the hemorrhage, it cannot be said that the fatty degeneration is very intense or extensive; as far as it goes this metamorphosis involves not only the cells of the interglandular tissue, but also the blood-vessels and the glandular and surface epithelia.

That these structural changes take place in the tissue coincident with the menstrual discharge, is unquestionably proved; but the relation they bear to the hemorrhage has not as yet been definitely ascertained, and anatomical appearances afford us no solution of this problem.

To my mind the relation is one of cause and effect; not only do I assert that the changes found to exist in the tissues are developed independently of the hemorrhage, but that they are, in fact, the cause of that hemorrhage.

A brief statement of certain facts proved in the course of our investigation will fully justify me in the position assumed:

1. *The congestion of the organ cannot alone cause the hemorrhage, as we find a more marked hyperæmia, a greater turgor of the vessels in the pregnant uterus and its mucosa, and yet no hemorrhage follows.*

2. *There are other physiological changes of the uterine mucosa in which a fatty degeneration of the tissues takes place, as in the gravid womb at term, or at any time previous when the ovum has perished and the tissues are thus prepared for its separation and expulsion, as in premature delivery and abortion.*

3. *The hemorrhage in the menstrual womb is always confined to the surface of the lining membrane, and the fatty degeneration is likewise more marked in its upper layer. I have never found extravasation of blood in the substance of the mucosa.*

Thus it appears to me that after a certain degree of tumefaction has been reached by the menstrual membrane, this change in its elements, this process of disintegration, is inaugurated, and rapidly developing, especially upon the surface, leads to the rupture of the distended vessels, and hemorrhage ensues.

This retrograde metamorphosis of the tissue may be due to deficient nutrition, owing to an insufficiency of the vascular system, no new formation of blood-vessels being observable.

The destruction and detachment of a large part of the more exposed elements of the surface, and even of the glandular epithelium, accompanies this process—in proof of which I will say that numerous epithelial cells, in a state of beginning fatty degeneration, are found imbedded in the whitish, somewhat bloody, mucus which fills the uterine cavity. I cannot, however, agree to the assertion that the *entire* epithelium of the surface is lost; until the beginning of the retrograde metamorphosis it certainly remains entire and intact.

Closely allied to the question last discussed is that of the temporal relation of the menstrual hemorrhage to ovulation.

The evidence we have of the simultaneous occurrence of these processes appears to me conclusive, and it seems but natural that the high degree of congestion existing in the organs of generation should cause at the same time in the uterine mucosa tumefaction and menstrual hemorrhage, and in the ovary ripening and rupture of the Graafian vesicle.

I do not propose to say that the escape of the ovum takes place invariably upon one and the same day after the hemorrhage has set in, but the specimens examined by me do go far toward proving that the rupture of the Graafian follicle generally occurs toward the close of the catamenial period.

I need only refer to cases already cited, two especially characteristic, known to have died shortly before the menstrual period, in which the mucous membrane already displayed the

menstrual tumefaction, and no signs of retrograde metamorphosis; in these uteri menstrual hemorrhage had not yet taken place, but was evidently soon to be expected, and no sign of a recently ruptured follicle was to be found in the ovaries.

In the ovaries of those whose death had taken place during the continuance of the hemorrhage clotted blood was found filling the cavity of the follicle, indicative of very recent rupture.

Cases that had died shortly after cessation of the catamenia showed the still tumefied, somewhat disintegrated membrane, and well-marked corpora lutea in the ovary.

These observations are moreover fully corroborated by the cases cited by Dalton in his prize essay, "On the Corpus Luteum of Menstruation and Pregnancy" (*Transactions of the Am. Med. Association*, 1851, p. 549), two of whose cases especially tend to prove the position here taken, and I will cite both, as they cover a time of the catamenial period not observed by me: In the first (p. 577), in which death occurred during the menstrual period, an enlarged Graafian vesicle, not yet ruptured, was found in the ovary; in the second (p. 578), death had taken place at the termination of the period and the ovary revealed a Graafian vesicle, prominent, and on the point of bursting. Equally convincing is the case related by Dr. Michel (*Am. Journal of Med. Sciences*, July, 1848, p. 261) of a woman executed on the second day of the catamenial flow, in whom the follicle was found filled with clotted blood, its rupture having but very recently taken place, probably hastened by the circumstances of the case.

I have felt it incumbent upon me to explain my views in this matter at greater length, because in our joint publication in 1873, the manuscript for which was completed by Dr. Kundrat during my absence in England, a theory is advanced with regard to the temporal relations existing between menstruation and ovulation, which I deem erroneous and wholly untenable. My honored friend and co-laborer is led to second the views of a clinical observer, Loewenhardt (*Archiv für Gynæcologie*, 1872, iii., p. 456), who attempts to prove that the ovum impregnated has not escaped at the menstrual period last preceding conception, but that it is coeval with the menstrual period following, at which only tumefaction of the uterine mucosa is found, but no discharge takes place.

By this theory the duration of pregnancy is made to be three-fourths of a menstrual period, or lunar month, less than is generally accepted, and, as the author claims that impregnation cannot take place in the four or five days immediately preceding menstruation, he must consider the rupture of the Graafian follicle to occur much earlier than the menstrual hemorrhage. In view of this, I do not think that my friend, Dr. Kundrat, will still maintain that Loewenhardt's clinical observations are borne out by our anatomical facts.

Kundrat very truly says that a comparison of the mucous membrane at a time immediately preceding the menstrual discharge with that of a uterus soon after conception, containing an ovum, proves the identity of structure, the only difference being in the greater development of tissue in the membrane of the fecundated womb, a difference merely in quantity, and not in quality.

I think that he errs, however, in the inference he draws that the menstrual growth and tumefaction of the uterine mucosa is to be regarded as simply a preparatory state for the reception of the impregnated ovum.

The tumefaction of the membrane probably favors conception in cases in which the cavity of the womb has become enlarged in consequence of previous deliveries, or a pathological condition of the tissues; in these uteri the increased volume of the mucosa certainly favors retention of the ovum or semen, by bringing the walls into closer proximity, a circumstance we need scarcely take into account in the normal condition of the organ, in which they are almost in contact with each other.

Enlargement of the uterine cavity and deficient development of the mucous membrane during menstruation are enumerated by Bischoff among the causes of sterility.

Of the menstrual abnormities of the uterine mucosa, none has attracted more attention than that known as dysmenorrhœa membranacea, in which the normal physiological process is increased to morbid intensity. This condition, found in women who have borne children, as well as in virgins, in which large shreds of the membrane are expelled, illustrates more forcibly than the normal state how deeply penetrating the retrograde metamorphosis after menstruation may become. Instead of a

mere gradual disintegration of the elements of the tumefied portion of the mucous membrane, and their rapid absorption, this entire upper stratum is detached and expelled, *in toto*, as decidua menstrualis. This is a morbid process, independent of fecundation or the congestive excitement of sexual intercourse, as it is present in two of our cases, which are undoubtedly virginal; in one, the post-mortem examination revealed the deciduous membrane in the vagina; in the other it was still partially adherent, the greater mass, however, being lodged in the cervical canal. A comparison of the expelled shreds with the remnants of the mucosa lining the uterine walls showed that an unusual and morbid development of the membrane had existed. The degree of retrograde metamorphosis could not well be estimated, on account of the extravasation of blood throughout the membrane and the post-mortem changes which had already taken place.

C. THE MUCOUS MEMBRANE OF THE UTERUS DURING PREGNANCY—THE DECIDUA.

1. *Normal development of the decidua.*

We have now studied the condition of the mucous membrane of the womb at the time of menstruation and ovulation.

All the examinations I have made of menstrual uteri have proved that the openings of the Fallopian tubes, as well as the internal os of the uterus are, even in that condition of the membrane, completely pervious, that the mucous membrane does not unite or even agglutinate at these places. At whatever period conception may take place, which it is not for me here to discuss, whether in the tumefied menstrual condition or not, and in whatever part of the female genital tract, the ovum, impregnated or non-impregnated, cannot produce a reduplication of the uterine mucosa in seeking its passage from the tube into the cavity of the womb by pushing the mucous membrane before it, as was once supposed. The theory of the origin of the reflexa based upon this view is refuted by the facts stated.

The ostia are not only pervious during the passage of the ovum, but continue so throughout pregnancy, unless they are closed by the growth of the ovum or its adhesion in the immediate vicinity of the tubar ostium or the os-internum; the latter

is always to a certain extent closed by the gelatinous secretion of the cervix, but never by the membrane.

The ovum is in most cases found lodged in the upper portion of the uterine cavity, upon the posterior wall, near the opening of one of the tubes.

Hence it is plausible to suppose, the mucous membrane being tumefied and completely occupying the uterine cavity, that the impregnated ovum, as it leaves the tube, can descend no farther, and lodges in the fundus, generally in the posterior wall of the succulent tissue (on account of the recumbent position), whether this tumefaction is the result of a congestive condition and increased vitality due to conception or of the periodical menstrual swelling.

In accordance with this theory we could readily explain the more frequent occurrence of placenta prævia in multiparæ in whom, as above mentioned, the cavity of the womb is larger, and the thickness of the mucous membrane often less than in the vigorous virgin organ, so that the ovum would not be so readily arrested, and would be more liable to sink down toward the os.

I must say that I have not been enabled to examine any authentic specimens of impregnated human uteri earlier than the second week after conception, so that, in order to supply this missing link, I must connect the appearance of the tumefied organ preparatory to the menstrual hemorrhage with that of a fortnight's fecundation.

From the time at which the ovum enters the uterine cavity and begins to develop in consequence of impregnation, the uniformity of structure previously found in the mucosa ceases, and we can no longer treat of the membrane as a whole, but must distinguish three separate parts in accordance with the relations they bear to the ovum:

1. *The larger portion of the membrane lining the cavity of the womb, with the exception of that part to which the ovum is adherent: the decidua vera.*

2. *That portion to which the ovum is attached, serving to unite it with the maternal system: the decidua serotina.*

3. *The portion enveloping and enclosing the greater surface of the ovum: the decidua reflexa.*

It is best to study these several parts, constituting the maternal membranes of the ovum, at the various periods charac-

teristic of their development, as they change greatly in the relations they bear to each other and to the ovum during the progress of gestation.

The Deciduæ in the First Month.

My observations upon the maternal membranes enveloping the ovum during the first month of pregnancy are mainly based upon the examination of three healthy uteri containing well-developed, perfect ova, the result of two and three weeks' fecundation; these I obtained by the kindness of Prof. Reichert, of Berlin. (Prof. Reichert has published a most interesting paper upon the condition of the embryo in one of these uteri, which he judges from the known time of menstruation to have been only twelve or thirteen days old: Beschreibung einer frühzeitigen menschlichen Frucht im bläschenförmigen Bildungszustande, etc. *Monatsbericht der Akad. der Wissenschaft zu Berlin*, Februar, 1873, No. 1, p. 108.) Equally serviceable for the examination of the decidua vera were two uteri received in Vienna, in which conception was ascertained to have taken place two or three weeks before death; in both of these the ovum had, however, been expelled—in one, which, with other of our finest specimens, we owe to the kindly interest of Prof. Rokitansky, the expulsion was caused by a traumatic peritonitis, resulting from a pistol wound in the abdomen; in the other the expulsion was owing to the intense vascular excitement of a pneumonia combined with pericarditis.

In addition to these we had at our disposal a very instructive ovum, of the size of a pigeon's egg, which had been expelled with the entire mucous membrane of the posterior wall and fundus of the womb. The Berlin uteri had been preserved in alcohol, whereas the Vienna specimens came under our observation in the post-mortem room, and were examined in a fresh condition as well as after hardening.

In order to be precise, as well as brief, I will confine myself to the description of one of these specimens which is characteristic of the condition of the organ in the third week of pregnancy.

The uterus was enlarged; it had lost its flattened pyriform appearance, and was full, rounded at the fundus and sides, and

highly congested. The thickness of its walls was increased to 0.6 inch (1.5 cm.), the body was 2.75 inches (7.0 cm.) in length, and the cervix 1.38 inch (3.5 cm.); the latter measurements varying in the other specimens from 2.0 to 3.15 inches (5.5 to 8.0 cm.), and from 1.18 to 1.38 inch (3.0 to 3.5 cm.) respectively.

The cervical canal was already obstructed by a plug of tenacious glassy mucus, and the walls of the cervix were also thickened, in consequence of which the palmæ plicatæ had become less prominent.

The mucous membrane of the uterine cavity was greatly hypertrophied, as much as 0.4 inch (1.0 cm.) in thickness, and very vascular, the intense injection of even the finest vessels giving it a uniform reddish color; its texture appeared still more loose and puffy than in the menstrual condition, and its development more rapid than that of the surrounding muscular coat; the membrane formed wavy projections, and even convolutions and folds of 0.078–0.118 inch (2.0 to 3.0 mm.) in width, and up to 0.04 (1.0 mm.) in height; the surface presented a cribriform appearance.

The tumefaction abruptly ceased 0.06 inch (1.5 mm.) above the internal os, forming an overlapping fold.

In the fundus, near the left tubar opening, I found a round tumor (more oblong in other cases), enveloped by the mucosa and projecting into the uterine cavity, above the level of the membrane, with about two-thirds of its circumference. The character of the mucous membrane was somewhat changed in the portion enclosing this prominence; it was more dense, quite smooth, and exhibited glandular ostia only at the base, which were distorted, though very distinct. By incision of the covering membrane the shaggy ovum was disclosed, its chorion covered with delicate villi uniformly developed over the entire surface.

After the ovum had been detached from the enclosing tissue, which was accomplished with the very slightest traction (unless the greatest care is taken, the simple handling of the organ will liberate it), a saucer-like depression was found in the mucous membrane immediately beneath the ovum, where its thickness was 0.04–0.06 inch (1.0 to 1.5 mm.) less than in other parts, though no other changes were visible on vertical section; upon its surface the glandular ostia were less distinct, and the

irregular indentations existing gave it a rugged, uneven appearance.

From the border of this saucer-like depression in the mucosa grew the fold of the membrane which served to enclose the ovum, some 0.0787 inch (2.0 mm.) in thickness at its base, while upon the height of the prominence it formed but a very thin layer. Such were the naked eye appearances; corresponding structural changes were revealed by microscopic examination.

The mucous membrane in those parts of the womb where the ovum is not adherent—in the decidua vera—presents the same features which we have already seen in its menstrual condition, only more fully developed.

The proliferation of interglandular tissue extends to a greater depth, and in the upper layers is still more marked than in the menstrual membrane; the individual cells are more enlarged, almost throughout the whole membrane; and in many the nuclei are found in the various stages of segmentation, indicative of active cell proliferation. The cells of the superficial layers resemble in character those of embryonic connective tissue; they are roundish or spindle-shaped, and frequently multiform from numerous processes sent out.

The finely granular protoplasm of the cell body contains a round or oval, coarsely granular nucleus.

The fibrous structure is almost lost, no new formation has taken place, and its delicate meshes are widely distended by the active cell proliferation which now extends throughout the entire membrane, even to the fundus of the glands.

The loosening of the tissue is now more marked in the lower strata, on account of the vascular distension and the glandular sinuosities; the crowding, closely-packed cells of the superficial layers give these greater density. Fig. 3. The openings of the glands become more widely separated from each other, and are often narrowed by the increase of a more compact interglandular tissue in the superficial layers, but the funnel-shaped depressions, which remain in the thickened membrane, render them even more distinct to the naked eye. Between the upper portion and the almost normal fundus of the glands, throughout the greater part of their course, they are wavy and very sinuous, frequently with a diameter of 0.006–0.01 inch (0.15 to 0.25 mm.).

The fundus of a gland is occasionally found amid the loosened, slightly infiltrated cellular tissue between the muscular fibres, which is probably explained by the fact that fibres of the rapidly developing muscularis have grown upward into the mucosa.

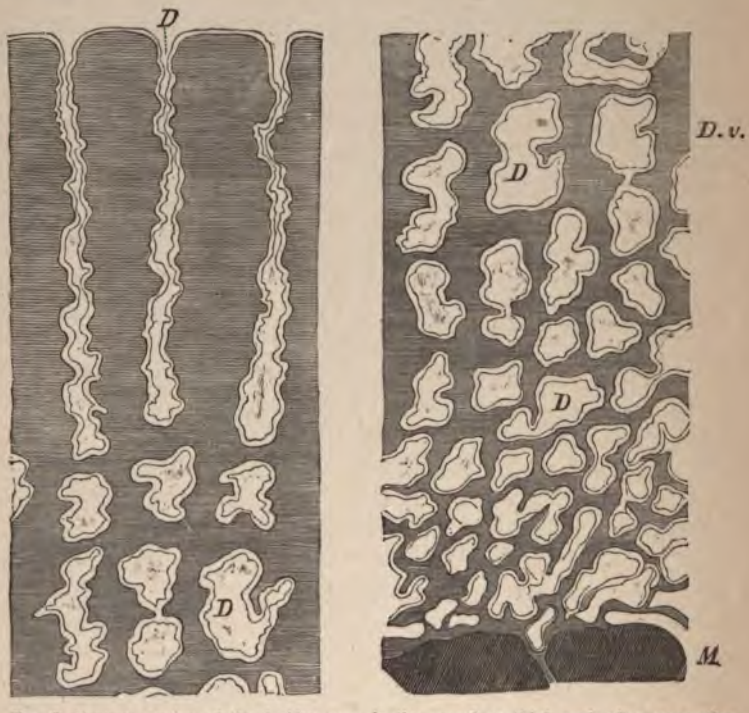

FIG. 3. Vertical section of the decidua vera in the second or third week after conception. 40 ×.
D. v. Decidua vera.
D. Uterine glands, more rectilinear in the upper half, and serpentine in the lower.
M. Muscular layer.

The cells of the glandular epithelium are enlarged, increasing in size as well as number; those lining the duct near its mouth have grown more in breadth than in height, and are flattened, compressed, often very irregular or detatched. The cells in the fundus alone seem to retain more of their normal appearance. The surface of the mucous membrane remains as in its previous condition, lined with ciliated cylindrical epithelium.

The decidua vera of the first week of pregnancy is, in short, characterized by a prolific development of the mucosa, especially of the interglandular tissue of its upper layers, and by an increase in length and volume of the glands themselves.

The mucous membrane at the point where the ovum is in contact with the uterine wall is developed in the same manner and undergoes the same changes as the rest of the membrane, the decidua vera. This part of the mucosa then, the decidua serotina, which at a later period underlies the placenta, is neither a new formation nor a plastic exudation. Though identical with the decidua vera and continuous with it in the first days after fecundation and homologous in structure, certain features peculiar to the serotina are already developed in the second and third week. Most apparent is its diminished thickness and the saucer-like depression above described.

The disparity in the size of the ovum and that of the glandular openings has long since demonstrated the fallacy of the theory which saw the impregnated ovum safely ensconced in one of the glandular tubes.

The examination of our earliest specimens leads me to concur in the views now generally accepted, that the ovum lodges in one of the depressions between the folds of the tumefied membrane, and that after impregnation has taken place, whether in the tubes or in the uterine cavity, the developing ovum is imbedded, pressed as it were into the soft and yielding membrane, by its own increased weight and volume as well as the resistance of the opposite wall; so that the convolutions of the decidua now surround the ovum, and the succulent tissue, like water over a sinking body, closes over it more and more until its folds almost envelop the ovum; then the approaching borders of this developing prolific structure soon unite and entirely cover the germ, thus completing the formation of the decidua reflexa.

This explanation was adopted after that theory had been abandoned by which the reflexa was considered a reduplication of the mucous membrane at the tubar ostium, pushed forward by the descending ovum, and after it had become apparent that the ovum could not well enter a glandular duct; its correctness is conclusively proven by an examination of the decidua reflexa and the decidua serotina. In describing the macroscopic

appearance of the membranes which envelop the ovum, we have already referred to the glandular ostia on the smooth outer surface of the reflexa. They are distinct and numerous only in that part of the membrane where it is continuous with the decidua vera, but are here visible both upon the outer surface of the reflexa and upon its more uneven, slightly roughened inner face which is turned toward the ovum.

Microscopic examination teaches us not only that these dis-

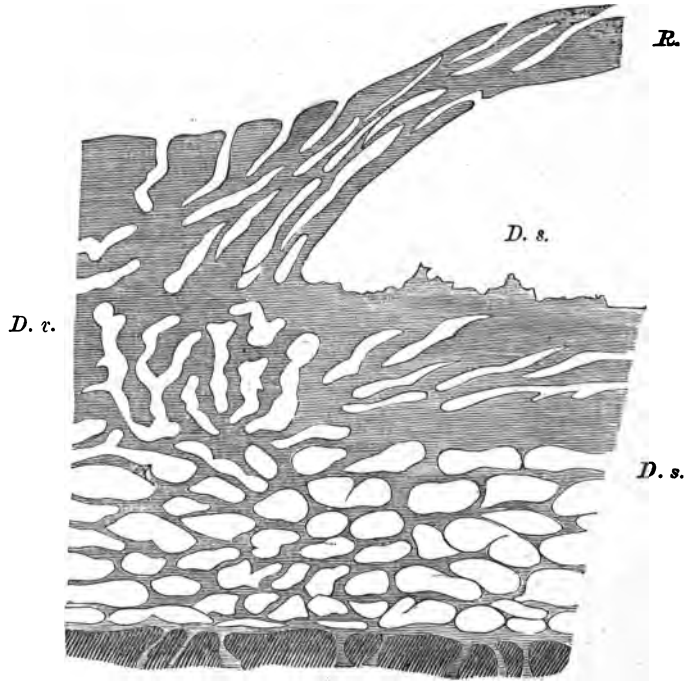

FIG. 4. Section through the maternal membranes in the second month of pregnancy. 20 ×.
D. v. Decidua vera.
D. s. Decidua serotina.
R. Decidua reflexa.
The ovum has been removed from its point of fixation between R. and D. s.

torted fissures are glandular openings, but also that the respective ducts, to which these ostia correspond, do not penetrate the reflexa diagonally, but pass longitudinally, parallel with its surface, to the depth of the mucous membrane from which it has sprung. But even where glandular openings are no longer

visible to the naked eye, in the thinner, most prominent portions of the reflexa, over the projecting pole of the ovum, the microscope reveals at intervals very long, narrow ducts which still retain their epithelial lining. The appearance of the openings of glands on both surfaces of the reflexa and of the longitudinal course of their ducts within its tissue proves the correctness of the assertion that this membrane is developed from folds of the mucosa whose approaching borders unite with each other.

I cannot state from personal observation at what period of impregnation and in what way these edges of the developing reflexa grow together, as I have no specimens of so early a time; the earliest examined by me, at the end of the second week after impregnation, all disclosed a fully formed reflexa with no trace of its previous condition or manner of union.

The structure of the reflexa is analogous to that of the superficial layers of the vera; its tissue abounds in the same large cells, and even the glandular ducts found in the reflexa all contain a more or less well preserved epithelial lining.

The development and structure of the decidua serotina furnish farther proof of the above-described origin of the reflexa; its development advances uniformly with that of the decidua vera at the commencement of pregnancy, before the pressure of the ovum becomes greater and before the formation of the placenta is begun, whereas at a subsequent period the interglandular tissue of the upper layers attains its characteristic density more rapidly.

The interglandular tissue in the upper and lower layers is the same as that of the vera, and the glands, moreover, open directly upon the surface like those of the vera, their ostia being merely somewhat distorted by the pressure of the superimposed ovum.

The surface of the serotina, however, differs somewhat in appearance from that of the vera, being more uneven and irregular. With the aid of a magnifying-glass, sometimes even with the naked eye, we can see that the small protuberances upon its surface are not due to adherent remnants of the villi of a forcibly detached chorion, and microscopic examination proves them to be pointed projections of the tissue of the serotina itself with sinuous indentations (D. s., Fig. 4). Similar shallow de-

pressions are found upon the rough inner surface of the decidua reflexa.

It was not possible for me to obtain a gravid womb of the first month for the study of the vexed question of the connection of the chorion with the decidua serotina and reflexa. The Berlin uteri I could not well use for an investigation so detrimental to the appearance of those unique specimens; as far as macroscopic examination can enable me to judge, I must say that I could find no connection beyond a slight superficial agglutination here and there; and Prof. Reichert, after careful examination of the ovum in the earliest of the uteri, twelve or thirteen days after impregnation, says, in the paper already mentioned, that no connection existed between the ovum and the serotina; the villi did not enter the glands, whereas the reflexa was in some places already agglutinated to the chorion, individual villi being imbedded in its tissue, as he erroneously thinks, entering the glands.

The first uterus of an early stage of gestation available for this investigation, and which was at once examined in the very best state of preservation, was one obtained from a woman in the second month of pregnancy, who had died suddenly, crushed by a falling embankment.

The union of the chorion with the uterine membranes enveloping the ovum was in this case extremely superficial; the slightest traction sufficed to completely detach nearly all of the villi of the chorion, but very few of the delicate terminal branches remaining adherent to the uterine envelop. This adhesion I found to be caused by a union of a two-fold character: it was in part owing to an agglutination of the villi to the depressions of the serotina and to the sides of its protuberances, the parts being simply superimposed and cemented by a connecting medium of tenacious mucus and detached epithelia; the continuity of the lining epithelium had been destroyed, and thus a more favorable surface was presented for an agglutination of the approximating elements; in part it was due to the fact that a few of the villi were already found imbedded in the developing projections of the serotina itself, this active proliferating tissue having enveloped the delicate branches in its growth. These villi alone, thus grasped, remained adherent to the serotina and reflexa when the ovum was removed.

Some of the villi were of course, before detachment of the ovum, found agglutinated to the surface of the serotina over the glandular ostia; but in a very few isolated instances only did microscopic examination prove a villus with its terminal branch to enter the mouth of a gland, and then it was never found to penetrate far into the duct which traverses the serotina obliquely in its superficial strata. The connection existing between the chorion and the decidua reflexa is the same in character, but the adhesions are still more scanty and delicate.

It was formerly maintained that the villosities of the chorion penetrate the glandular ostia and enter the ducts of the glands themselves, thus forming a comparatively firm connection between the ovum and the surrounding uterine membranes. This is still universally assumed, and is upheld, I am sorry to say, by some most eminent and well-known observers. It is a very plausible theory, which is demonstrated by most striking and conclusive illustrations, duly copied in all, especially obstetrical, text-books; but no macroscopic and microscopic preparations, proving the same, are in the hands of any of the authors who advocate its truth, and can, indeed, not be found.

My examinations and still preserved specimens prove that no such relation exists between the ovum and the uterine membranes, that the villi do not enter the gland tubes, but that the adhesions existing are owing to an agglutination of the parts and to the growth of the serotinal tissue around the villi.

This is the case in the human female, and I have found a similar condition in some of the higher mammalia, but have never seen the villi of the chorion regularly penetrating the glandular tubules. With regard to the surface epithelium I can only say that I have still found it in places upon the decidua vera, so that it has not as yet entirely disappeared; but I can make no definite statement as to the extent of its preservation on account of the difficulty of retaining that delicate layer at this period of development.

The blood-vessels of the entire mucous membrane are enlarged, as is already apparent in the macroscopic specimen; they have increased in length, and extend their ramifications into the most superficial layers, and in the serotina even into its projecting villosities. In the serotina we have, moreover,

found vessels which strongly suggest a new formation by their branching processes and the irregularity of their lumina.

The reflexa at this period is still vascular, showing blood-vessels accompanying the longitudinal course of the glands.

The Deciduæ in the Second and Third Month.

Our knowledge of the condition of the membranes during this period is gained from the examination of the uterus in the second month of pregnancy, already referred to, which contained two ova, each with its own chorion, in a single sack of the reflexa, a uterus in the latter part of the third month, and numerous ova expelled with the maternal membranes.

The uteri were larger than those of the previous month, showing an increase both in the thickness of the walls and in the size of the cavity; the ovum, however, had not correspondingly developed, and did not as yet completely occupy the entire uterine cavity. In both the ovum was attached, as is usually the case, at the posterior wall and fundus, and the space left in the cavity beneath was filled with an opaque, viscid, mucous fluid.

The decidua vera was up to 0.236 inch (6.0 mm.) and over in thickness, whereas the serotina was less than 0.157 inch (4.0 mm.), still puffy and convoluted with the cribriform appearance of its surface. The reflexa, which was only in partial apposition to the vera, presented a thickness of 0.0787 inch (2.0 mm.) at its periphery, near its line of continuity with vera and serotina, but not over 0.039 inch (1.0 mm.) in its central portions; its external surface was smooth, and in the uterus of the third month also its inner face. In the latter specimen the distorted glandular ostia were only to be found in the peripheric portions of the reflexa, and that membrane was already more firmly united to the chorion; chorion and amnion were in close apposition throughout, but as yet easily separated. The surface of the serotina in the third month has become more irregular and villous than in the second, and is more intimately connected with the villi of the chorion, which have also developed in that part of the ovum, having increased in length and become more densely ramified, forming shaggy tufts. Upon the rest of the chorion, over the projecting portion of the ovum, often designated as chorion læve, the villi have

apparently diminished; as no further development has taken place either in size or numbers, and the existing ones are more widely separated by the expansion of the growing ovum, they seem smaller and less numerous.

The multiform cells in the interglandular tissue of the decidua vera are very much enlarged, and that tissue itself is more dense and homogeneous in its upper layers, more delicate and minutely porous in its deeper strata.

The enlargement of the glands in the lower third [0.0098–0.0118 inch (0.25–0.3 mm.) in diameter] almost to their fundus, makes transverse sections of the membrane appear like a meshwork with larger meshes and finer threads [0.00196–0.00394 inch (0.05–0.1 mm.) in thickness] in the lower strata, while the spaces become smaller, and their walls heavier [0.0098 inch (0.25 mm.)] nearer the surface. The fundi of the glands, which are now almost parallel to the muscularis, are not enlarged, and near the

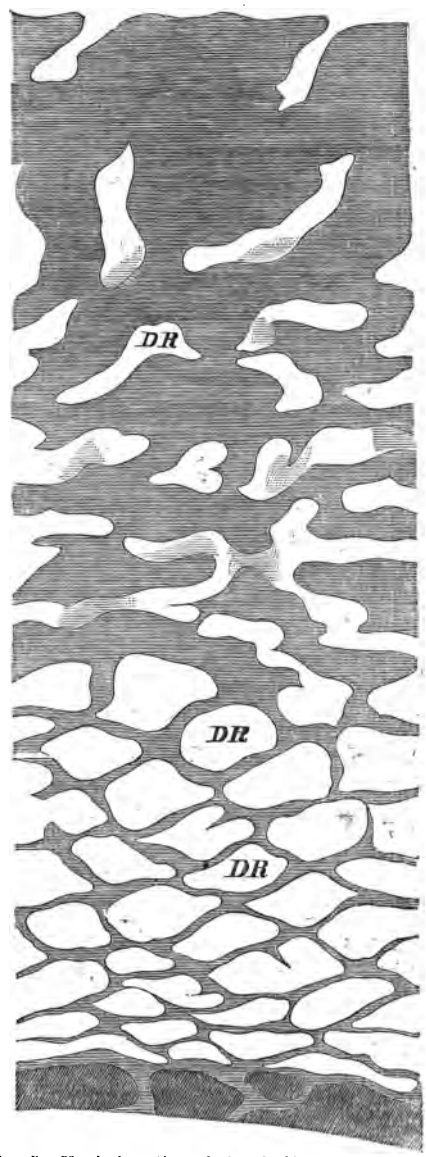

FIG. 5. Vertical section of the decidua vera in the third month of pregnancy. 35 ×.
D R. Glandular space, already beginning to assume the appearance of meshes in the lower stratum: narrower in the denser upper layer.

ostia, which are still characterized by the funnel-shaped depressions, they are often even narrowed.

In some places the epithelium is well preserved, in others it is wanting, and a finely granulous mass is found instead. The occurrence of blood in the glandular cavities is probably pathological. Of the surface epithelium not a trace was visible upon any of the numerous sections examined. I am, however, unable to say whether this was not merely due to an imperfect conservation of the subject.

The projections of the serotina were more distinctly developed, and in their growth had imbedded individual tufts of the chorion within their proliferating tissue, above the former surface of the uterine membrane; yet it might appear to the casual observer that these tufts, which may be said to be the first indication of the future cotyledons, had penetrated the serotina. Still comparatively few of the villi had become attached in this manner, and it was evident, too, that they did not penetrate the glandular ducts, though some were agglutinated upon the funnel-shaped depressions which form their ostia. The terminal branches of the villi rarely approach the serotina in a direction vertical to its surface, but more often obliquely, and even run parallel with it.

The glands of the serotina presented an appearance almost precisely like those of the decidua vera, wide and very sinuous in their course, but narrow at their ostia and fundi; the epithelium was likewise only partially preserved; in part it was detached, or, its outlines having become obliterated, it remained as a finely granular mass within the glands. Similar granular masses were also found adherent to the terminal villi of the chorion, probably the remnants of the surface epithelium, which serve, as above stated, together with the scanty mucus, to agglutinate the parts.

The cells of which the reflexa is mainly composed are very large, corresponding to those of the interglandular tissue in the upper layers of the vera; the glandular ducts are very much compressed and contracted, often visible only as narrow fissures; the blood-vessels of the reflexa, with the exception of those in its periphery, are in process of obliteration.

I have already referred to the close connection existing between the chorion and the decidua reflexa; in the prepara-

tion of microscopic specimens, chorion and amnion, whose smooth surfaces approximate, are readily separated, but chorion and reflexa adhere more firmly to each other, presenting irregular, rough surfaces of contact; the villi of the chorion are forced, as it were, into the tissue of the reflexa, and are enveloped by it.

The diminished thickness of the reflexa seems to indicate that the growth of the ovum is more rapid than that of the membrane enclosing it; this is indeed the case, but the development of the reflexa has not entirely ceased, as even a macroscopic comparison of the specimens will show, and the condition of its cells and the segmentation of their nuclei is a still more conclusive proof of its activity and growth.

From the Fourth Month to the Termination of Pregnancy.

Our observations as to the condition of the mucous membrane of the uterus during this period of pregnancy are based upon the examination of nine uteri, all of which were obtained in a most excellent state of preservation; every one of the latter months of pregnancy, from the fourth month onward, is represented by one, some even by two, pregnant uteri.

At about the fourth month the size of the ovum has become such as to completely fill the uterine cavity. During the three first months the growth of the uterus is more rapid than that of the ovum; the uterus is enlarged, its walls have become thicker, and its cavity, increased in size, is but partially filled by the slowly growing ovum. After the fourth month the germ surpasses the enveloping matrix in its growth; the womb has become comparatively passive, its cavity is distended by the now rapidly developing ovum, and the uterine walls, extending over a greater surface, are reduced almost to their normal thickness, diminishing still more in the later months of pregnancy. The cervical canal does not become distended, and in no way contributes to the enlargement of the uterine cavity, as some authorities still suppose.

The ovum in the fourth month is still freely movable in the uterine cavity, adherent only by its placental attachments, while the enveloping reflexa is not yet in any way united to the surrounding uterine walls. This free movable portion of the

ovum, which projects into the uterine cavity, is covered with a delicate, smooth, colorless, almost perfectly transparent membrane, consisting of three distinct layers, the two fœtal membranes, the chorion and amnion, and the maternal envelope, the decidua reflexa.

The former are still easily separated from each other, but the reflexa can only be detached from the chorion by the exertion

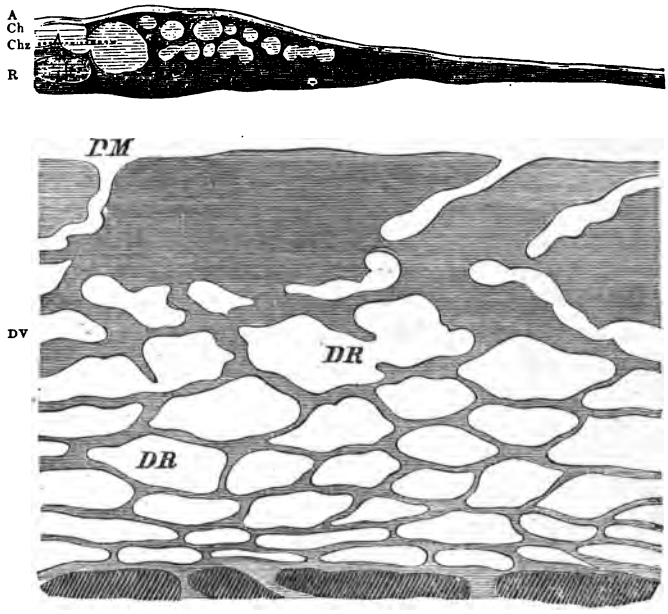

FIG. 6.—Vertical section of the maternal and fœtal membranes in the fourth month, magnif. 35 diam.
A. Amnion
Ch. Chorion.
Chz. Villi of the chorion imbedded in the reflexa.
R. Decidua reflexa.
DV. Decidua vera.
DR. Glandular spaces, giving the meshy appearance to the lower stratum.
DM. Glandular ostia.
M. Muscular wall of the uterus.

of some little force, and then adherent shreds remain here and there upon its surface.

The decidua vera has changed essentially in appearance; its surface, though still cribriform, is no longer puffy and undulating, as its convolutions have become expanded by the dilatation of the uterine cavity; throughout its entire extent it has been

reduced from its greatest thickness of 0.4 inch (1.0 cm.) during the first month to a layer of not over 0.07 inch (1.8 mm.) Transverse sections show an upper, more uniform, dense membranous stratum, and beneath this a spongy laminated tissue, the meshes of which become especially prominent when immersed in water.

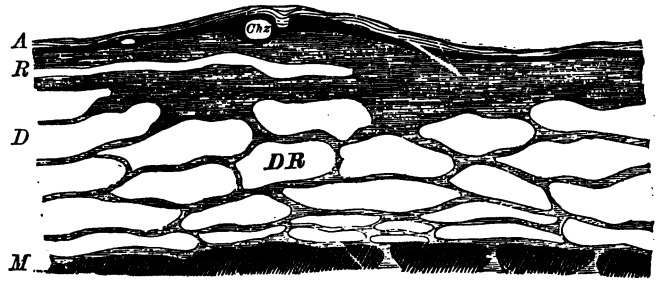

FIG. 7. Vertical section of the maternal and fœtal membranes in the fifth month of gestation. 35 ×.

A. Amnion.
Chz. Villi of the chorion imbedded in the reflexa.
R. Decidua reflexa.
D. Decidua vera.
DR. Glandular spaces of the lower stratum.
M. Muscularis.

After the fifth month that part of the ovum which projects into the uterine cavity with its enveloping membranes, among which I must class the already adherent reflexa, can no longer be so easily removed from the surrounding uterine walls; the opposing surfaces of the decidua vera and the reflexa are now partially agglutinated; in later months it is impossible to separate them without lacerating one or the other of the membranes, and finally they become firmly united throughout their greatest extent. The decidua vera has not only become still thinner, 0.0472 inch (1.2 mm.), but the appearance of its surface has also undergone a change; instead of the former characteristic funnel-shaped glandular ostia we see but very shallow depressions with a well-defined border. Sections still reveal the same structure, the uniform, dense upper layer and the spongy meshwork beneath.

After the fourth month chorion and amnion are also more firmly agglutinated, though even to the termination of pregnancy the connection is never such that with a little care the

transparent, colorless membranes cannot readily be separated from each other. Not so with chorion and reflexa, their adhesion having become so firm that parts only of the membranes can be detached; in those places where the reflexa has been successfully removed the outer suface of the chorion now also appears perfectly smooth.

DEVELOPMENT AND STRUCTURE OF THE PLACENTA.

The most important and essential change in the chorion as well as the mucosa has been produced at their point of contact by the formation of the placenta.

The villosities of the chorion, whose development upon this part of the ovum we had already observed in the second month, have now, by a more vigorous growth and the extensive ramification of the individual villi, formed a spongy, tufted mass of the shape of a flattened ovoid, and are so closely united with their terminal sprouts to the protuberances and the surface of the serotina, that they cannot be separated without lacerating its tissue, parts of the superficial layers clinging to the tufts of the removed chorion. After the fourth month, then, the placenta is fully formed, and we can recognize its component elements much more readily than in the mature structure, where they are completely fused. In fact, it is only in the developing organ that we can with certainty distinguish a *placenta fœtalis*, by which I mean the villosities of the chorion, and a *placenta uterina*, the maternal part. Of the latter the text-books give a very indefinite, if not a totally false, conception; it is composed of only the most superficial of the dense upper layers of the serotina, and in its greatest extent of the protuberances which spring from these and envelop the ramifications of the villi in their growth.

From the beginning of the second half of gestation to the end of pregnancy, the union of the fœtal and maternal parts of the placenta is continually strengthened by the imbedding of the sprouting, downward-growing tufts in the proliferating tissue of the serotinal protuberances; the individual cotyledons also become more intimately connected, thus adding to the increased density of the structure.

With the exception of these changes upon its surface the

serotina, analogous to the vera, presents the same features which I have already described in the previous months, only that its thickness is somewhat diminished; it possesses the same dense upper layer, now sending its projections between the ramifying villi, and a spongy, laminated stratum beneath, somewhat narrower than that of the vera. Its structure continues unchanged to the termination of pregnancy, though the layers still decrease in thickness, the lower meshes and fundi of the glands preserve their epithelium more or less perfectly.

At no time are fœtal villi found in the glandular spaces of the lower laminated layer, or in the narrow fissures which represent the ducts in the upper strata; so that the statement I have made with regard to the relation of the chorion to the serotina in the earlier months of pregnancy, that the villi do not penetrate the glandular ducts, is equally true of the more fully developed ovum.

In the trabeculæ of the meshwork we find large blood-vessels corresponding to the vascular development in the upper layer of the membrane at this point, and to the blood sinuses in the muscularis beneath. New formed capillaries extend into the protuberances of the serotina.

This, unfortunately, is all that I am enabled to state with positive assurance, upon a point so necessary to a full understanding of the vascular structure of the placenta; more our specimens have not revealed.

Probably these capillaries grow with the proliferating tissue as it becomes more and more interwoven with the fœtal tufts, and thus maternal and fœtal vessels are brought into closer contact, but their walls and the surrounding tissue, though thinned and atrophied, are preserved, so that the villi do not "float" directly in maternal blood.

Such are the facts with reference to the formation and structure of the placenta, as far as I have myself observed them.

I am unable to explain satisfactorily to my own mind the origin, development, and structure of the large blood sinuses of the placental portion of the serotina, which all authors describe as the most important feature of that structure. Ercolani and Braxton Hicks deny their existence; the latter, having examined eight placentæ of different months of pregnancy *in situ*, found no blood between the villi, or only a mere trace, which had

come from some ruptured fœtal capillaries, and remarks that this fact seems a direct contradiction to the theory of large maternal sinuses surrounding the villi.

Our injections of the placenta would indeed make it appear that the villi of the chorion project directly into the maternal sinuses, being only lined with their own proper epithelium, and not by a second distinct layer which might be construed to be the wall of the serotinal vessel, so that they would seem to be bathed in maternal blood coursing in the spaces between the villi. Though the injections were the very best, made *in situ*, from both maternal and fœtal vessels, by the careful and skilled hands of Dr. Fleischel, and the results are analogous to those of other investigators, I cannot preclude the possibility that the injected fluid had ruptured the delicate capillary walls and penetrated the interstices of the tissue, thus producing the puzzling appearance described, so that the sinuses would be mere artificial products. This is all the more probable, as the capillaries are large, and the resistance of their yielding walls is, moreover, greatly diminished by the fatty degeneration which they have undergone, and the post-mortem changes that have taken place.

As regards the character and development of the maternal circulation, I am not as yet prepared to make any definite statement, and hence prefer to give only the positive results of my investigation, without derogating from their merits by coupling them with theories, however plausible.

The facts stated, new and widely different from the theories generally maintained, are not only verified by all the specimens examined, but I also see a convincing proof of their truth in the analogous development of corresponding structures in the higher mammalia.

As in other instances the study of comparative anatomy has led to a more perfect understanding of our own organization, so the more simple relation of the maternal and fœtal membranes in animals serves to explain the more complicated structure of the human placenta, and it is found to be in perfect harmony with the conditions I have described; we have the same dense, hypertrophied superior layer of the mucous membrane, whose protuberances interlace with the villi or folds of the chorion.

It is almost impossible to conceive how theories such as those

generally accepted with regard to the structure of the placenta could so long be taught in this period, which exacts close scientific inquiry. It is a mechanical impossibility that the villi of the chorion should enter the uterine glands, as even a superficial examination will reveal—(1.) The glandular ducts are more or less rectilinear, simple, at most bifurcated, whereas the villi are densely ramified.

(2.) The villi, with all their branches, are infinitely more numerous than the uterine glands in that small part of the mucous membrane which is in contact with the ovum.

(3.) The shape of the terminal branches is not that of delicate tendrils which might insert themselves into the open ducts, but they are mostly short, somewhat thickened, sometimes bulbous buds, of a shape so that they can be firmly grasped by the proliferating serotinal tissue. And finally (4.) the terminal sprouts of the villosities are most all larger, of a greater diameter than the glandular tubules, as we have seen them in the serotina of the first to the third month, so that in the normal condition they could not penetrate. By these current theories the placenta is made to develop regardless of physiological laws and at variance with all known histological processes as well as the teachings of comparative anatomy, so that if those views be true we must allow an utter disregard of fundamental laws in favor of this one structure. I have endeavored most conscientiously to demonstrate the connection existing between the villi of the chorion and the serotina; we have seen that it is an interlacing of new-formed tissue above the original surface of the membrane, and that the villi do not enter the uterine glands. Thus the very foundation of one of the most widespread theories falls to the ground.

But even less in harmony with facts is the account which has been given of the farther development and the structure of the placenta. It does not explain how the glands can, or do, grow upward, and send out branching diverticula to fit the ramifications of the villi; and no actual investigations, no specimens, are brought forward to support such a theory. It further changes the uterine follicles into vascular sinuses, in which the villi of the chorion float about; whereas, it is a well-known physiological fact that blood at once coagulates upon entering such interstices of tissue.

Another theory would have the villi push the tissue of the serotina before them and penetrate the maternal vessels, which again would bring the nutrient blood of the mother in contact with a coagulating foreign body, the surface of the fœtal villosities.

The results obtained by Ercolani (Sul processo formativo della porzione glandulare o materna della placenta. Bologna, 1870) in his thorough examination of the placenta uterina in man, the ape, and the horse, in the ruminantia, rodentia, chiroptera, carnivora, and insectivora, agree so perfectly with my own observations upon that part of the uterine mucosa that I have passed lightly over the old theories; and the fact that my statements harmonize so fully with those of the learned Italian, of the existence of whose paper I was not aware at the time those researches were made, is a further proof of the correctness of the doctrines I advance.

RETROGRADE METAMORPHOSIS OF THE MEMBRANES.—MACROSCOPIC APPEARANCES.

The condition of all the parts, the chorion, the uterine mucosa, and the placenta, continues about the same as that last described until the termination of gestation. In only one respect is a marked change found to take place, and this becomes apparent, even to the naked eye, during the last month of pregnancy, occasionally at a somewhat earlier period; in cases of abortion, it is observed during whatever month they may take place, at the time of their occurrence.

The covering membranes of the ovum, including the decidua reflexa, first lose their transparency, and become opaque, whitish, with a pale, yellowish tinge; then, too, the upper layers of the decidua vera grow paler and assume a delicate, continually deepening, yellowish hue, which gradually extends to the meshwork of the deeper spongy layers; lastly, the decidua serotina shows signs of a similar change, which is, however, by far less intense. This opacity of the membranes can at any time be readily observed in the mature ovum after expulsion. I have twice seen this discoloration, most exquisitely marked, in the decidua vera, giving it a pale, yellowish-gray color; once in the case of a woman who had died at the termination of

pregnancy from embolism of the pulmonary artery, resulting from thrombosis of the vena saphena, and again, in a patient who died of sheer exhaustion during protracted labor.

DECIDUA VERA.

The decidua vera has, during the fourth month, as indicated by its macroscopic appearance, undergone some very essential structural changes. The upper, uniformly dense, membranous stratum, which certainly forms a part of the vera, and is developed from that membrane only, as is proved by depressions of the glandular ostia upon its surface, and the absence of any connection whatsoever between it and the approximate surface of the reflexa at that period, is composed almost entirely of very large cells which Friedländer calls epithelioid. The resemblance of these cells to those of pavement epithelium is due to the very marked enlargement of the cell body in surface, and the prominence of its nuclei. It is this appearance of the cells, as well as their size, which has induced certain observers to regard them as a proliferation of the epithelia, either of the surface of the mucosa, or of the uterine glands, and it must be admitted that the cells bear a close resemblance to epithelial cells in their general characteristics, especially in sections of hardened specimens. In fresh specimens, however, and those kept in conserving fluids, they reveal a very different character, proving their similitude with the embryonal cells of young connective tissue, especially such as are found in certain myxomata.

In the more fully developed decidua, between the fourth and the eighth month, we distinctly see them to be branching or spindle-shaped, and not round or polygonal pavement cells. At a later period the body of the ramified cells greatly preponderates over the processes which branch out in different directions. During the first months I have observed numerous round bodies, resembling white blood-corpuscles, between the cell processes, which are more rarely seen toward the end of pregnancy. Pl. I., Fig. VI.

As gestation approaches its termination, the spindle-shaped cells disappear in part, while the large, branching cells increase in number, and as their processes contract and become less numerous, these multiform cells assume the appearance of pave-

ment epithelium. Only slight traces of the pale, delicate, fibrillary meshwork of the normal mucosa are now to be found in this layer. The cells seem to be united by a finely granular intercellular substance.

I have dwelt upon the cell proliferation which takes place in the upper layers of the mucous membrane and which we have found even in its menstrual condition, where the lower layers were hardly engaged in the process; but after conception the development of the cells both in numbers and size is found throughout the entire membrane, though still much more marked in the upper than in the deeper strata. This increase in volume, together with a change of form, steadily progresses, so that in the third and fourth month individual cells near the surface of the membrane already assume the epithelioid appearance; and this, be it remembered, at a time when the glands are as yet distinctly visible, lined with well-preserved epithelium, and when the surface too, at least partially, retains its epithelial cells, normal in character and arrangement.

At this period, therefore, when the limits of the interglandular tissue on one hand, and those of the glands and of the surface epithelium on the other, are still well defined, it is readily apparent that the large cells above described belong to the interglandular tissue proper. If seen only in the latter months of pregnancy their origin would, indeed, appear somewhat obscure, as they have then assumed an epithelial character almost throughout, and the tension of the vera, together with the pressure of the growing ovum upon its surface, have transformed the upper strata of that membrane into a uniformly dense layer, in which the lumina of the glands have become very indistinct, and the glandular as well as the surface epithelium has almost entirely disappeared.

In extra-uterine pregnancy, and in the non-pregnant horn of a uterus bicornis or bilocularis, the cells of the interglandular tissue assume the peculiar character described, while at the same time the uterine glands and their lumina are well preserved. But even in the normally developed decidua vera we can with certainty trace the glandular tubules and their ostia in this layer, called by Friedländer the "large cell stratum," and ascertain that these large cells are distinctly interglandular. During the fourth month the openings of the

glands, though, indeed, very indistinct, may still be recognized as delicate, oblique, somewhat funnel-shaped depressions, their ducts appearing as oblique fissures mostly narrowed so as almost to bring their walls in contact.

The lower stratum of the decidua vera, which presents that spongy lamellar structure, appears under the microscope as a network composed of several layers of superimposed meshes, mostly rhomboidal in form, whose longitudinal diameter is parallel to the uterine surface, and greatly exceeds the vertical after the end of the fourth month, as seen in Fig. 8, DR.

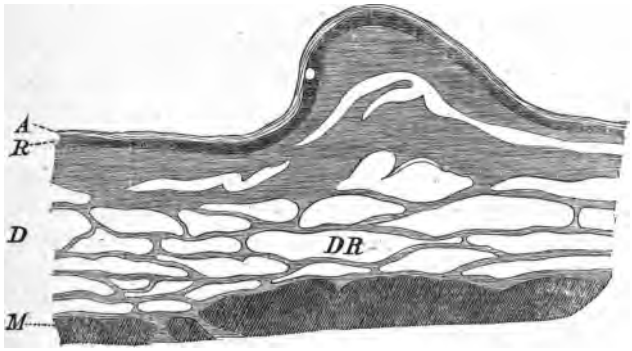

FIG. 8. Vertical section of the maternal and fœtal membranes in the last month of pregnancy.
Lettering as in Fig. 7.

The trabeculæ of this meshwork, which in the fourth month have a thickness of 0.00196 inch (0.05 mm.), gradually diminish in size during the subsequent months of gestation, until they are at length reduced to 0.0004 inch (0.01 mm.) or less in their transverse section. They are generally thicker in the upper layers of the meshwork than in the lower, and are directly continuous with the upper cellular stratum of the vera.

That these interstices originate in the glandular ducts and sinuosities is abundantly proven by their contents and the lining of their walls, as well as their development up to the fifth month, after which time there is no farther change.

Friedländer asserts that these spaces are lined with a single layer of very perfect epithelial cells, partly pavement and partly cylindrical. This I cannot assent to, as it is contrary to the facts observed. We have seen that even in the vera of the third month the glandular epithelium has been lost in some of

the enlarged and sinuous ducts, and finely granular mucous masses are found in its place, which are probably the product of a disintegration of its cells. As gestation progresses, after the third month, the glandular epithelium gradually disappears or undergoes the above change; the upper layers of the membrane are first involved, so that in the fourth month an epithelial lining can be found in but few of the glandular fissures; it then begins to disappear in the sinuosities of the deeper strata, and during the last month of pregnancy it is only in the fundi of the glands and in the very deepest meshes, close upon the muscularis, that the epithelia are preserved.

The interstices of the meshwork contain masses which represent the various stages of transition from well-preserved epithelium to the granular conglomerations. The glandular epithelium which, during menstruation and immediately after conception, is higher and larger than in the membrane at rest, becomes shorter, more clumsy and flattened as the glandular ducts are transformed into the compressed sinuosities of the network, so that toward the termination of pregnancy we do find the epithelia in the form of comparatively flat cells, reminding one of pavement epithelium, partly adherent to the walls of the interstices and partly detached.

At the same time some of the cells seem to undergo a very peculiar metamorphosis (Pl. I., Fig. VI. *b*). In those meshes in which the cells of the lining epithelium are already flattened, certain odd formations begin to appear between the individual cells, either singly or in groups, and partially adherent to the walls of the spaces as if belonging to the lining structure. They are very bright, generally cylindrical bodies, which are either wholly homogeneous (Pl. I., Fig. VI. *a*) or reveal more delicate and transparent globules imbedded in their mass (Pl. I., Fig. VI. *e*). The larger of these bodies contain several such globules of varying size, the smaller only a single one. The intermediate stages found and the existence of these bodies between well-preserved, adherent epithelia, as well as the regular arrangement, especially of the smaller ones, along the walls of the meshes, all seem to indicate that they originate from the epithelium of the glandular spaces, and are the product of a retrograde metamorphosis of its cells (Pl. I., Fig. VI.).

The fundi of the glands do not participate in the changes

which take place in the glandular ducts and their epithelia. We have seen that during the menstrual period and in the first months of pregnancy the appearance of the fundi is but little altered, some being, perhaps, slightly enlarged. We find them in the same condition throughout the latter period of gestation; a change in the direction of their axes, which are always more or less inclined to the perpendicular direction of the ducts, however, becomes noticeable during the fourth month, after which time they lie almost parallel to the surface of the muscularis. The epithelium of the fundi is not destroyed, but its cells appear compressed, broader, and shorter.

The interglandular tissue in the trabeculæ of the meshwork consists of large embryonal cells, similar to those of the uppermost layers; though in this stratum they are longer and narrower, and do not show that marked increase in size, nor do they undergo the same transformation toward the termination of pregnancy as those of the upper layer. (Pl. I., Fig. V.)

As we approach the muscular stratum the intercellular fibres of the connective tissue become more numerous, and finally interlace with those surrounding the muscular fasciculi.

The vessels supplying the upper layers take their course through the trabeculæ of the network, and it is hence irregular and tortuous; their lumen is no longer as large as we have found it during the earlier months, and as gestation approaches its termination they continue to diminish in size as well as numbers.

DECIDUA REFLEXA.

The decidua reflexa persists as a distinct membrane throughout the duration of pregnancy, and remnants of that structure are found upon the surface of the chorion after expulsion of the fully developed ovum. Some authorities assert that the reflexa disappears during the latter months of pregnancy, probably because its very delicate tissue, then adherent to both chorion and decidua vera, is blended with each and no longer so distinctly appears as a separate structure. If we, however, follow the development of the fœtal membranes we can readily continue to trace the decidua reflexa to the very termination of pregnancy, and it becomes apparent that the tissue

which envelops the surface of the chorion, after the agglutination of the ovum to the vera, is that of the reflexa.

We have seen that in the fourth month the ovum completely fills the uterine cavity, and its surface is in close contact with that of the decidua vera, though in no way united with it. Sections made through the fœtal membranes at that period show the outer surface of the chorion covered with a layer of large cells similar to those in the upper strata of the vera, whose surface is intact; the atrophied, widely separated villi of the chorion are imbedded in this layer of cells, which represents the reflexa; traces of glands or blood-vessels I could not discover in this delicate structure.

No farther changes take place, and the reflexa retains this appearance to the end of gestation. After the fifth month its outer surface becomes closely united to that of the decidua vera, but even then both membranes, notwithstanding their identity of structure, can be readily distinguished under the microscope by certain characteristics of the reflexa. The tissue of the reflexa imbibes coloring matter more readily than that of the vera, and whether the specimens have been stained, or simply hardened in the yellowish chromic acid or bichromate of potash, we find a stratum of somewhat deeper color immediately beneath the chorion, which is that of the reflexa. The cells of the vera also are more densely crowded, more compact and flattened towards the surface. In many specimens we can detect a delicate line of demarcation between the two deciduæ.

The villi of the chorion have not entirely disappeared, as is maintained by some, but are seen here and there imbedded in the tissue of the reflexa, thus serving to identify that structure; they are those "bright, spherical spaces," which Friedländer describes in the most superficial layers of the vera, directly beneath the chorion, apparently ignorant of their origin or character.

A farther proof of the continuance of the villi we find in ova of from three to nine months' pregnancy, in which we can separate the decidua reflexa from the chorion near the placental margin, owing to the greater thickness of the reflexa at this point; and in carefully removing it we observe delicate yellowish-white, sometimes branching threads, passing obliquely from the outer surface of the chorion to the inner face of the reflexa,

their extremities imbedded in its tissue. These thread-like fibres, which are more numerous near the borders of the placenta, are villi of the chorion, and were formerly erroneously interpreted as obliterated blood-vessels.

The connection between the vera and reflexa is not a very intimate one, as indicated by the existence of a line of demarcation, but a mere agglutination of the mechanically approximated membranes. The complete absence of fibrous elements in the contiguous surfaces suggests an agglutination by the same homogeneous intercellular substance which serves to unite individual elements of their tissue.

Both membranes are at that time denuded of their surface epithelium; this is already lost from the outer surface of the reflexa at a very early date when still preserved upon the vera; from the surface of the latter it does not disappear until the ovum has come into close contact with the uterine walls throughout. In several specimens from a gravid womb of the fifth month, in which partial agglutination between the vera and reflexa had already taken place, we found the membranes still separated here and there by a thin layer which was delicately striated in some places, and finely granular in others, and which, from its appearance and position, we could only interpret as a remnant of the disintegrated surface epithelium. There were no indications of previous hemorrhage which would have justified other conclusions.

DECIDUA SEROTINA.

As regards the serotina, it is necessary to give a precise definition of the terms used, since the relation of that membrane to the surrounding structures is very much changed after its close union with the chorion in the fifth month. We now distinguish two parts: the placenta uterina and the serotina proper. The placenta uterina is the dense upper layer and the tissue developed from this, which interlaces with and grows around the villi of the chorion; it is that part which, with the villi of the chorion, forms the placenta, and is expelled as such. The serotina proper is the lower stratum, that part of the uterine mucous membrane which underlies the placenta, uniting it to the muscular layer, and which, after

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the separation of the placenta, remains attached to the uterine wall. The serotina proper is a meshy, lamellated tissue, forming a thinner layer than the corresponding lower stratum of the vera; transverse sections accordingly reveal a network of but very few meshes in thickness. In structure they are identical with those of the vera; the fundi of the glands also present an appearance similar to those of the vera; they are parallel to the surface, are not enlarged, and retain their epithelium. Above this meshwork formed by the enlargement of the glandular spaces is the thin, denser stratum, in which here and there narrow fissures and small interstices appear. This upper portion of the original serotina takes part in the formation of the placenta, and cannot well be isolated; the processes which we have seen upon the serotina as a proliferation of its sub-epithelial tissue giving first an uneven, then a villous appearance to the surface, have more fully developed and extend into the fœtal placenta to over half its thickness, enveloping the individual villi as well as the groups of cotyledons in delicate sheaths of its tissue. Parts of the maternal membrane are thus inseparably interwoven with the fœtal villosities; but those processes which form the placenta uterina do not extend through the entire depth of the fœtal stratum to the surface of the chorion itself; and in this I can but confirm the statements of late investigators.

The fibrous reticula are closer and more prominent in the serotina than in any other parts of the decidua. In the later months but few traces of the surface epithelium remain in the shape of scarce recognizable cells adherent to the villi here and there; the glandular epithelium too has disappeared, except in the fundi, and nothing remains in the meshes but disintegrated portions, and those opalescent glassy bodies forming larger conglomerations.

The large cells with finely granular protoplasm and large well-defined nuclei, of which several are either bunched together or regularly distributed, seem to belong to the villi of the chorion, apparently to their growing terminal filaments. These elements are often found wholly isolated in the tissue of the serotina, which is probably due to the fact that the connection between the terminal buds and the fully developed branches, from which they spring, is a very loose one, so that they are easily torn from the stem by the teasing of a specimen.

RETROGRADE METAMORPHOSIS, MICROSCOPIC.

We have seen that the fœtal as well as the maternal membranes undergo a change toward the termination of pregnancy which becomes apparent by the opacity of the former and the yellowish tint observed in the latter. Microscopic examination reveals a fatty degeneration, amounting almost to total disintegration of the cells in chorion and amnion, less marked and uniform in the decidua. This retrograde metamorphosis is initiated in the deciduæ in the last month of pregnancy, but is observed in the fœtal membranes at a much earlier period, and at term becomes more intense than in the maternal tissue.

It is impossible to fix the precise period at which the metamorphosis begins, unless a very large number of post-mortem examinations can be made, as the same change is observed in ova prematurely expelled, so that whenever this degeneration of the membranes is found in a gravid womb, I could not say whether it was the result of the physiological process, or of a pathological condition which would have resulted in abortion had life been preserved.

In the decidua vera this degeneration mainly involves the large cells of the upper layer, those of the lower stratum being less affected. In the serotina it is also well marked and even more fully developed than in the vera.

Though found in cases of abortion and premature delivery, I am not prepared to say that the fatty degeneration of the fœtal membranes is the main or primary cause of the separation and expulsion of the ovum.

CONCERNING THE EXPULSION OF THE DECIDUA.

At Term.—Having studied the development, structure, and connections of the decidua throughout the entire period of gestation, we will now examine the changes which take place during labor, which of these connections are severed, and what part of the maternal membranes, if any, is expelled with the ovum. We are fortunately in possession of all the specimens desirable for a satisfactory investigation of this much-disputed point. Our results are derived from the examination of, 1,

aborted ova; 2, after-births at term and in cases of premature delivery; 3, the uteri of women who died during or immediately after delivery.

In the afterbirth we must carefully examine the outer or maternal surface; the layers of the serotina adherent to the placenta and the shreds of vera and reflexa upon the chorion will indicate the line of separation between the ovum and its maternal envelope, showing how much of the latter has been carried away with the expelled contents.

The fœtal envelope is an opaque, whitish membrane, 0.02–0.03 inch (0.5–0.75 mm.) in thickness, with an even, smooth inner surface toward the fœtus; the outer surface, however, is soft and irregular, from the adherent shreds of a pale yellowish tissue. It consists not only of the membranes proper of the ovum, the chorion, and amnion, but also of the reflexa, with parts of the decidua vera; these latter are from the upper cellular layer of the vera, either part of the tissue only, or the stratum in its entire thickness; being forcibly torn from their natural connections, they present a soft, villous surface, with the pale yellowish color, due to the fatty degeneration of the vera.

I shall refer only to two of the uteri examined with regard to this point which were most characteristic: one, the uterus (a uterus bicornis) of a woman, who, surprised by sudden and severe labor pains, died in the street from hemorrhage before the ovum was expelled; the other from a woman who died immediately after a very tedious instrumental delivery.

The cavity in both cases was lined with a delicate, soft, convoluted membrane, of a yellowish color, the surface of which showed small, shallow, yet well-defined depressions. In endeavoring to remove this soft, but apparently dense membrane from the walls of the uterus, it was found united to it by a deeper layer of spongy, laminated tissue, which remained, with almost its entire thickness, upon the muscular stratum, a few of its meshes only being separated with the upper layer.

Microscopic examination revealed in this membrane the well-known structure of the decidua vera, with fatty degeneration of its elements throughout, and deprived in part of the more superficial of the large cells of its upper layer. The depressions on the surface corresponded to the glandular fissures here laid open by the removal of the superficial layer. The mesh-

work of the lower stratum was in the first case 0.039 inch (1.0 mm.) in thickness, but in the second 0.078–0.118 inch (2.0–3.0 mm.), being abnormally developed. The epithelium in the fundi of the glands was perfectly preserved in both.

Remnants of the decidua were also found in the uteri of women who died hours, and even in those who died several days after delivery;- in but few was the membrane so perfect or so distinctly perceptible as in the two cases cited, inasmuch as the structure is covered with coagulated blood or inflammatory products which penetrate its tissue more or less, and cannot be removed without partially, at least, destroying the membrane itself.

So also remnants of the mucous membrane are always found upon that part of the uterine wall to which the placenta was attached, if no pathological condition intervened and the separation of the placenta has been spontaneous. In this place, however, the dense upper layer of the serotina, forming part of the placenta uterina, is generally detached, and expelled *in toto*, as a part of the afterbirth; the loose mesh-work of the lower stratum alone remains upon the muscular layer, and generally escapes the observer, being concealed beneath the numerous thrombi which protrude from the uterine vessels; moreover, the tissue at this place is generally infiltrated with blood, and the few remaining meshes are still more obscured by being felted with the adherent coagula.

I must add that in most cases the shreds which are found adherent to the womb after parturition, and are generally looked upon as parts of the fœtal membranes proper, are not such, but membranous shreds of the decidua—its partially detached upper stratum. I have myself seen this mistake made in post-mortem examinations in well-known institutions. Yet it occasionally does happen—even after normal labor and spontaneous expulsion of the ovum—that shreds of the chorion remain in the uterine cavity for days and weeks attached to the still firmly adherent decidua. The fatty degeneration of the tissue, which is most intense in the upper layers of the vera and serotina, may well be the cause of their easy separation from the structures with which they are fused.

To recapitulate: the parts of the maternal membranes adherent to the ovum, expelled in normal parturition at term, are

the whole of the decidua reflexa, the entire upper cellular layer of the serotina, and the more superficial parts of the upper stratum of the vera; the greatest part of the vera and the spongy lower layer of the serotina remain *in utero*.

In Abortion.—It now remains for us to examine the relation of the maternal membranes to the aborted ovum, exclusive of evidently pathological conditions. Ova expelled during the first month, and mostly those of the second, have no maternal membranes adherent to them, but show the shaggy, whitish surface of the enveloping chorion; at this period the ovum is often aborted in a very marked pathological condition, together with the whole of the upper layer of the mucous membrane, which closely adheres to it. In the third and fourth months the reflexa, more firmly united to the chorion, is expelled with the ovum, forming a smooth covering over the greater part, of its surface.

In the fourth month parts of the vera may already adhere to the outer surface of the reflexa, and traces of the proliferating tissue of the serotina are found between the cotyledons formed by the tufts of the chorion. The envelopes of ova expelled after the fifth month have all the parts which we have found composing the fœtal membranes after parturition at term, or adhering to them, the entire structure being, of course, much more delicate; in addition to the parts found in the previous months, a transparent layer from the superficial stratum of the serotina adheres to the maternal surface of the expelled placenta.

A fatty degeneration of the membranes in aborted ova is seen at a very early date.

I have seen the fœtal membranes in the fourth month, discolored and opaque, at a time when they are still vigorous and firmly united in the normal ovum. Often, too, the fatty degeneration is very complete in those parts of the decidua which remain in utero; yet it is sometimes missing, especially when the abortion has been caused by an injury or some other external influence; in such cases the fœtal membranes are quite transparent while the serotina is of a gray or grayish-red color.

In aborted ova we frequently see a shred of membrane, perhaps three-fourths of an inch in width, pending from the

edge of the placenta over the outer surface of the fœtal membranes; it has a jagged, rent border, as if torn, a shaggy outer surface, and an areolated smooth inner aspect toward the ovum; its color, when not altered by an infiltration with blood, is identical with that of the serotina. The outer surface of this membrane is directly continuous with the serotina at the protruding edge of the placenta, its inner surface with the reflexa. The areolated appearance of this surface extends beyond the line of fusion to the reflexa, but upon the face of the latter the depressions become distorted and appear more like elongated fissures.

This membrane, as is evident from the description of the surfaces, continuous on the one hand with the serotina, on the other with the reflexa, is part of the decidua vera, and is mostly up to 0.18 inch (4.5 mm.) in thickness.

The agglutination between the approximate surfaces of the vera and reflexa near the placental margin is very imperfect, even during the last months, and in some places is wholly wanting; the upper layer of the vera is readily separated from the lower, but directly continuous with reflexa and serotina, so that when the ovum is expelled with these membranes, shreds of the vera are torn away with it, and are not fused to the surface of the reflexa, but freely pendent.

The shreds of tissue which are sometimes discharged from the womb for several days after an abortion, and even after delivery at term, are portions of the decidua vera; in abortions occasionally shreds of the fœtal membranes; very rarely are they detached portions of the inner muscular layer.

From the character of the membranes adherent to the aborted ovum, as well as from the examination of uteri after their expulsion, we see that the condition of the maternal membranes in abortions after the fifth month is precisely the same as at term, the greater part of the vera remaining *in utero;* previous to the fourth month the entire membrane is preserved and a thicker layer of the serotina remains than is found after parturition; in many of the abortions of the first and second month the maternal membranes, on the contrary, suffer more than at any other period, only the deepest strata of vera and serotina remaining *in utero.*

2. *Appearance of the Decidua Enveloping the Aborted Ovum.*

We can readily recognize the individual membranes in ova expelled after the third month, but it is frequently a very difficult matter to distinguish the separate tissues in ova aborted during the first and second month, as they are generally in a more or less pathological condition.

The ova are not only very much disfigured, and their appearance greatly altered by hemorrhage in and between the various membranes, but they are often so deformed by the disintegration of the embryo and the abnormal development of the surrounding membranes, that it is impossible to identify the various parts without a thorough knowledge of their normal condition, and the pathological changes to which they are subject.

In abortions during the first weeks after conception a triangular shaggy mass is sometimes expelled corresponding in form and size to the cavity of the womb at that period; it is a pouch, which is either completely closed or possesses only a small opening with ragged edges at its apex, and is of a deep dirty-red color. The walls of this sac are from 0.118–0.157 inch (3.0–4.0 mm.) in thickness, soft, succulent, intensely injected and infiltrated with blood, of a rough villous exterior, while the inner surface is smooth, somewhat puffy and cribriform. Upon this inner surface, near the broader base, we find a spherical protuberance of the same deep-red color, which, upon section, proves to be a second smaller pouch adherent to the walls of the first, and enclosing an opaque bloody fluid, often with a partially decomposed embryo only a few millimetres in length. These sacs then are a product of conception; the larger outer one consists of the upper layer of the entire mucosa, vera and serotina, which has been expelled as a complete membrane enclosing the ovum with the reflexa, the projecting pouch upon its inner surface. In such cases the entire vera is prematurely and abnormally developed; the interglandular tissue already contains the large characteristic cells which are not usually found until the latter months of pregnancy.

The arrangement of these epithelioid cells has, however, been disturbed; they have been separated in many places by extravasations of blood, which are more or less extensive throughout the entire tissue, and the cellular elements often appear upon

the borders of larger extravasations or surround smaller effusions in concentric layers. This is the form of aborted ova from which the belief originated that the decidua vera was a closed sac, as the narrow openings which should correspond to the tubar ostia are always closed by coagula, and generally the space of the internal os as well. This occlusion is indeed deceptive, and cannot so readily be distinguished from real fusion of the tissue, since the vera itself, thoroughly infiltrated with blood, has the same consistency and the same deep-red color as the coagula closing the ostia.

A form of ova greatly resembling these are those which are expelled with only parts of the vera attached; but in all of these cases the decidua is in a pathological condition prematurely hypertrophied, infiltrated, and distended, by extravasations of blood.

The ova, which are aborted toward the end of the second and in the third month, even in the beginning of the fourth, generally show the smooth outer surface of the enveloping reflexa with jagged shreds of the vera adherent to the base of the former membrane. These ova vary in size according to the period of their development and their pathological condition. We often find an accumulation of serum or blood in the cavity of the amnion or between amnion and chorion, or chorion and reflexa; most common is the extravasation of blood between amnion and chorion. The embryo has mostly died long before the expulsion of the ovum, and is apparently retarded in development, or the delicate tissue has been wholly absorbed, leaving no trace of the embryo, and but little of its proper membranes. Ova expelled at this time, which have better preserved their normal appearance, are round or oval in shape, covered throughout their greatest extent by a smooth, reddish-gray membrane, mostly infiltrated and impregnated with blood; it is somewhat thicker, 0.04–0.08 inch (1.–2. mm.), than the membrane enveloping the ovum at a later period; upon the borders of that part of the ovum which was adherent to the uterine wall it is continuous, with shreds of a firmer membrane pending from its sides. At the point itself where the ovum has been detached the villi of the chorion are freely exposed; in other cases the tufts are so closely cemented by coagulated blood that the smooth and rounded surface of the ovum appears un-

broken even at this point; if the coagulum is large the ovum becomes pear-shaped. Upon section the coagulum with the clotted villi presents a placenta-like appearance.

Still another variation which we find in the shape of the ova is due to a conical protuberance, an elongation, as it were, of the lower, reflexa-covered pole of the ovum produced by coagula in or upon the reflexa, but always attached to its most pendent, lowest point.

These conical elongations of the lower extremity of the ovum are often of considerable length, and are even constricted in places, as if by contraction of the internal os; they generally originate in an accumulation of blood in the lowest portion of the sac formed by the reflexa which is distended and the membrane itself impregnated with blood. This blood, however, does not seem to come from the vessels of the reflexa, as the extravasation in these cases extends between chorion and reflexa up to the former point of attachment of the ovum, while the tissue of the reflexa itself shows no extravasations or other signs of hemorrhage, and is only impregnated with blood where in contact with the coagula.

An early hemorrhage greatly alters not only the shape of the ova, but also their general appearance, color, and consistency; yet the structure can be identified, its various parts recognized, and the extent of the membranes traced by the adherent shreds of the vera.

Such is the character of the ova aborted up to the fourth month, as we generally see them; the more normal ovum, as it is often expelled during the first two months, a delicate vesicle surrounded by the villous chorion, is mostly lost amid the clots of blood discharged, and is hence but little known.

3. *The Decidua in the Uterus Bicornis and in Extra-uterine Pregnancy.*

It is well known that a tumefaction of the mucous membrane of the womb takes place after conception, even when it does not serve to nourish and protect the ovum, as in the non-pregnant horn of a uterus bicornis or bilocularis, and in cases of extra-uterine pregnancy a decidua is formed which bears a close resemblance to that of the normal womb; I will only refer to

certain points revealed by the examination of such uteri, which have a direct bearing upon the questions discussed.

The uterine mucosa at term, in such cases, corresponds in its development to that of the decidua vera in the third month of normal pregnancy, at which period the surface of the decidua is still intact, not as yet compressed by the expanding ovum, nor united to the approaching surface of the reflexa. The resemblance is perfect as regards the general appearance, the sieve-like surface, the degree of tumefaction, the enlargement of the glands and the proliferation of the interglandular tissue. The difference existing is that the cells of the interglandular tissue assume the epithelioid appearance which we have found in the upper stratum of the normal vera during the latter months of pregnancy, whereas the glandular ducts and the intervening tissue of the lower stratum undergo no farther changes, so that we do not have that lamellated meshwork characteristic of the deeper layers of the normal vera; the glandular epithelium is comparatively well preserved.

The possibility of the fixation and growth of the ovum and the development of the placenta upon tissues other than the mucous membrane of the womb can, I think, be rationally explained only upon the basis of the facts demonstrated:

1. *That the decidua, to which, in ordinary pregnancy, the chorion is attached, is not an epithelial structure, but connective tissue.*

2. *That the villi of the chorion are only fused with the proliferating connective tissue of the most superficial stratum of the serotina, and do not enter the uterine glands; that the villosities have no necessary but merely an occasional and incidental connection with the glandular structure.*

The occurrence of extra-uterine pregnancy, in which the ovum is surrounded by tissues not of an epithelial character and forms its attachments upon structures which possess no glands, crypts, or follicles, serves on the other hand, to corroborate my results.

D. THE REGENERATION OF THE MUCOUS MEMBRANE AFTER PARTURITION.

During the first week after parturition the appearance of the inner surface of the womb changes but little.

It is at first covered with a layer of bloody mucus, which assumes a yellowish-red color and becomes less fluid toward the fourth or fifth day. After carefully removing this more or less tenacious mass, while the specimen is immersed in water, a soft, velvety, yellowish-red membrane is found lining the uterine cavity; it has a thickness of 0.04–0.08 inch (1.–2. mm.), and generally a somewhat uneven meshy surface.

That part of the uterine walls to which the placenta was attached presents a very different appearance, owing to the irregular protrusions caused by the thrombosed vessels, but its surface is covered with a very delicate layer of the same yellowish-red, filmy membrane which lines the rest of the cavity.

Microscopic examination again reveals the familiar structure of the decidua, though in a somewhat altered condition; the dense upper layer is for the most part wanting, and the laminated structure of the spongy lower stratum is exposed; the glandular spaces of the meshwork are filled with blood, its tissue, full of hemorrhagic effusions, is infiltrated with young, round cells, but still shows those large, here more fusiform cells, characteristic of the decidua in an advanced state of fatty degeneration, extending even to the deepest layers.

At this period, then, the lower, more fibrous stratum of the uterine mucosa, in which the type of connective tissue is readily recognized, is exposed. The large cells peculiar to the decidua gradually disappear from the tissue; their connection with the surrounding elements has ceased; they are disintegrated and carried away. The bloody mucus covering those remnants of the decidua contains round cells, detached, fatty, decidua cells and fragments of these, free nuclei, fat granules, and some few epithelia, and, of course, blood-corpuscles in great quantities. The number of cells and the fatty detritus in this fluid give it the yellowish tint which becomes more apparent as the quantity of commingled blood diminishes.

In the second week after delivery only a very thin film, hardly to be called a membrane, is left upon the inner surface of the womb, and it already begins to assume the appearance of an active granulating tissue, although still retaining the well-marked yellowish-red color. The placental site is less uneven, the thrombi are smaller, more resistant and discolored, and the mucus upon its surface has less consistency, and contains

fewer cellular elements than that in other parts of the uterine cavity.

The greater part of the decidua has now been expelled with the continued discharge, and only the deepest layers remain; these are thoroughly infiltrated with round cells, and but few of the fatty disintegrating decidua cells are to be seen.

This dissolution of the interstitial tissue lays open the deepest of the glandular spaces and even the fundi, which, as Friedländer correctly states, are no longer parallel to the surface of the muscular layer, but still very oblique.

Although a new formation of surface epithelium is not yet inaugurated, the tissue is no longer wholly devoid of epithelial covering, inasmuch as the exposed fundi, in which the glandular cells have been preserved, form part of the surface, and their epithelial lining appears as that of the surface. An active cell-proliferation now begins in these remnants of the glandular epithelium, as we see by the segmentation of its nuclei.

In the third week after delivery the inner surface of the womb is in some cases already lined with a very thin smooth membrane of new formation, which is still covered by more or less of a pale-yellowish mucus, sometimes streaked with blood.

The new membrane appears to be of a yellowish color when seen *in situ*, owing to the transparency of the delicate film which transmits the fatty color of the underlying muscular tissue; here and there it exhibits a very decided pigmentation of ochre-yellow, brownish-red and even black.

Upon microscopic examination the structure superimposed upon the muscularis is found to be a layer of connective tissue up to 0.006 inch (0.15 mm.) in thickness, rich in young formative cells; its surface is protected by a delicate epithelium, and the developing glands are represented by short crypts or sinuous ducts. The placental site alone is at this period still devoid of a surface epithelium.

This was the appearance presented by two of the uteri of the third week; in a number of others which were examined at that period the condition of the lining membrane was somewhat backward, corresponding more to the description given of its structure in the second week; but as many of these *post-partum* specimens were obtained from patients whose death

had been caused by acute disease, pneumonia, pericarditis, meningitis, etc., and not from cases of sudden death from injuries, I am safe in stating that the restitution of the uterine mucosa takes place as early as the third week after parturition, at which time the membrane, though frail and delicate, not over 0.006 inch (0.15 mm.) in thickness, is perfect in its elements, the glandular structure, interstitial tissue and surface epithelium being all represented. The farther development of the interglandular tissue which is accompanied by the elongation and extension of the ducts (thus again bringing them into a vertical position) and the proliferation of the glandular epithelium complete the restitution of the mucous membrane of the womb to its normal condition.

In a uterus of the fifth week after parturition the mucous membrane had already attained a thickness of 0.0315 inch (0.9 mm.), the substratum of interglandular tissue contained an excess of round cells, but was in all other respects of normal appearance, the glands vertical and extended, lined with normal epithelia, 0.0007 inch (0.018 mm.) in height.

Upon the placental site I have in many cases found the regeneration of the membrane to progress more slowly; in the two apparently normal cases of the third week, and in one of the fourth, in which, in other parts of the womb, the young membrane was protected by a surface epithelium, no traces of it had as yet appeared upon that part of the uterine wall before occupied by the placenta.

This involution of the uterus and the restitution of the mucous membrane may be greatly retarded by disease, as is evinced by an examination of cases which have lingered with chronic affections, in which the inner surface of the womb presents a granulating appearance for months after parturition, and is found to consist of young granulating tissue, partly again in fatty degeneration without any trace of glandular structure and surface epithelium.

Such cases would lead us to infer that, although the patient may recover and the disease be cured, the uterine mucosa is in them never perfectly restored.

If the whole of the decidua should be detached, either in consequence of disease, or of tedious instrumental delivery, a perfect mucous membrane could never be reformed; the sub-

stratum might be developed from the interstitial connective tissue of the muscularis, but would then line the cavity of the womb as a cicatricial layer of connective tissue, devoid of surface epithelium or glandular structure, as those elements had been destroyed from which a new mucous membrane might be developed. If totally expelled the mucous membrane could not be regenerated; but in those cases, whether tedious instrumental delivery, or spontaneous expulsion of the ovum, in which the membrane is *apparently* expelled *in toto*, the lowest meshes with the fundi of the glands, or, in extreme cases, only the exposed fundi, still some part of the mucosa remains *in utero;* the muscular fibres are not laid bare, and restitution is readily explained.

The decidua undergoes the same process of disintegration and restitution after abortion and premature delivery as it does after normal parturition. After abortions which occur during the first four months of pregnancy the fatty degeneration of the decidua cells is confined more to the upper layers, and the restitution of the mucous membrane to its normal condition is more rapidly accomplished.

The yellowish, brownish, red and black pigmentary deposits existing in molecular form, or in opaque globules in the tissue of the mucous membrane, are characteristic of deep-seated hemorrhage, and may be looked upon as an almost conclusive proof of recent delivery, whether the ovum has been expelled at term, or aborted in the early months of pregnancy. After menstruation no such pigmentary deposit is found, probably on account of the superficial character of the hemorrhage.

PART III.

THE MUCOUS MEMBRANE AFTER THE CHANGE OF LIFE.

With the change of life the mucous membrane of the uterus, which we have seen in a state of continual physiological activity from the time of its complete development at puberty, begins to atrophy. The substratum of connective tissue becomes more fibrous, dense, and homogeneous; its cells contract and lose their succulence, the glands narrow, and are obliterated either entirely or in part. Small cysts are often formed by the partially obliterated ducts, and, when near the ostia, they appear like delicate, glittering dew-drops scattered over the otherwise smooth surface of the now thin, hard membrane.

PLATE I.

FIG. I.—Vertical section of the inner surface of the pregnant uterus at term, from a woman delivered by Cæsarean section immediately after a sudden death, showing the maternal and fœtal membranes in their natural relation:

A. Amnion.
Ch. Chorion.
R. Decidua reflexa.
DV. Decidua vera.
DR. Glandular spaces.
DI. Contents of the glandular spaces.
Z. Villi of the chorion.
M. Muscularis.
(Hartnack, Obj. VIII., Ocul. III.) 400.

FIG. II.—Vertical section of the placenta, fœtal, and maternal membranes, and the uterine wall from the same specimen. Natural size.
Pl. Placenta.
m. muscularis in its entire thickness.
Other letters as above.

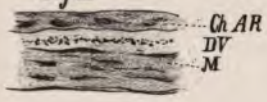
FIG. III.—Section of the uterine wall, with maternal and fœtal membranes at some distance from the placental attachment. From same specimen. Natural size.

FIG. IV.—The large (epithelioid) cells from the upper stratum of the vera (b), and from the reflexa (a), from a uterus in the ninth month of pregnancy.
(Hartnack, X immersion. Ocul. III.) 750.

FIG. V.—Interglandular tissue from the meshwork; the trabeculæ. (Hartnack, X immersion. Ocul. III.)

FIG. VI.—Contents of the glandular spaces; metamorphosed glandular epithelium. (Hartnack, X immersion. Ocul. III.)

a. Large amorphous glassy globules.
b. Glandular epithelium in process of transformation to the semi-transparent globules.
c. Granular corpuscles and nuclei, representing the remnants of disintegrated epithelium.
d. Glassy globules imbedded in the granular mass.
e. Free globules containing smaller transparent bodies.



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